

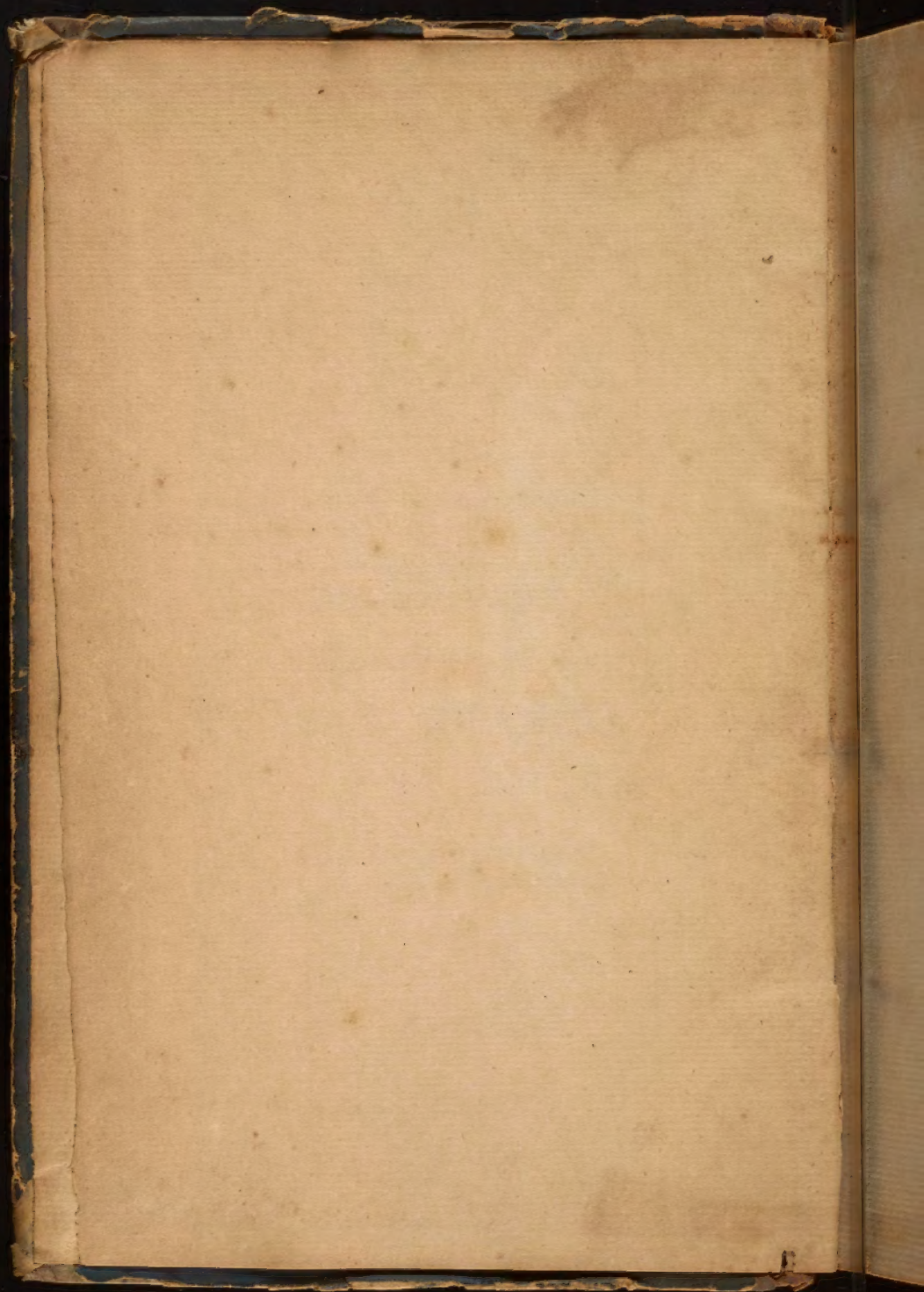
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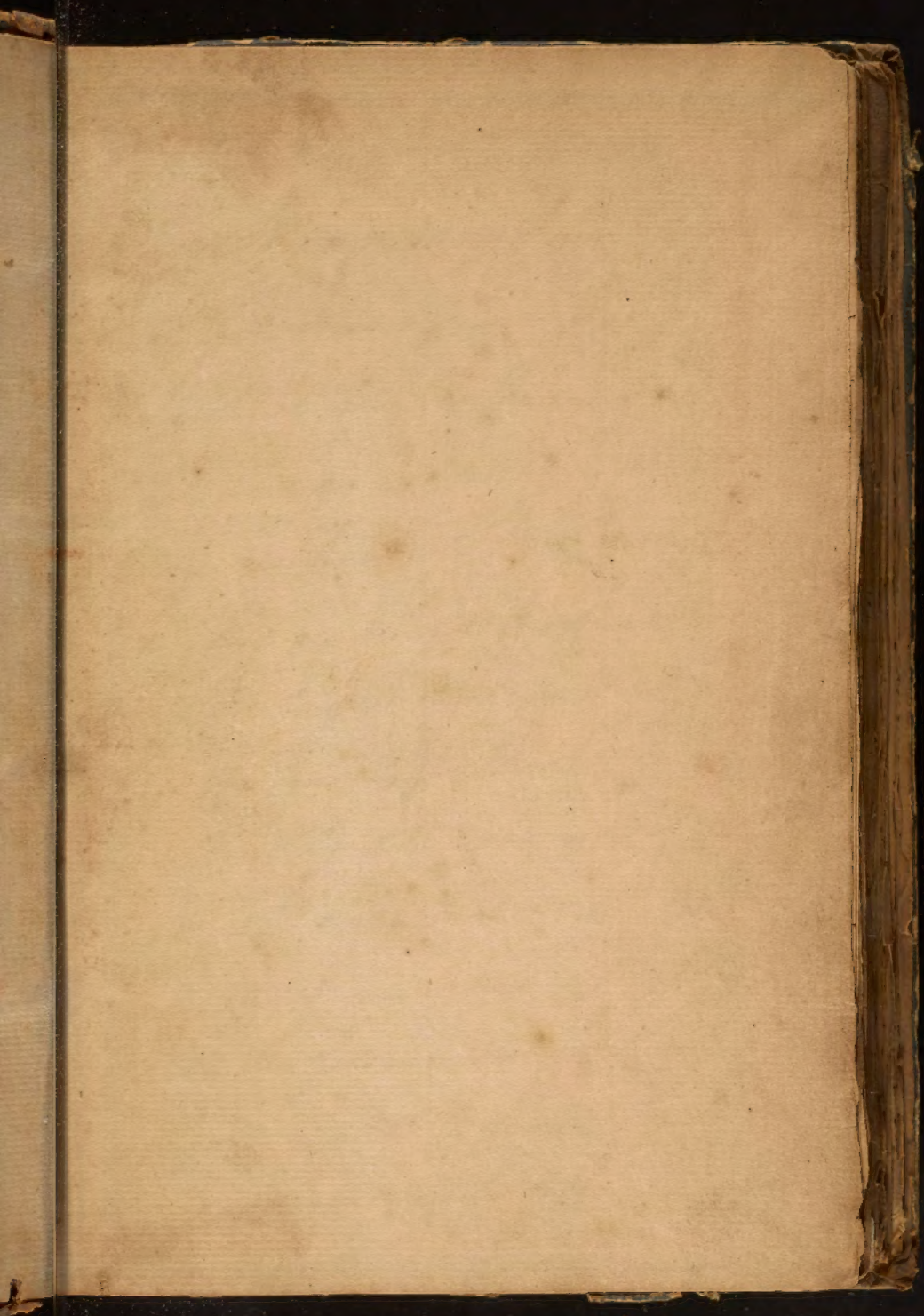
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.....
COMMUNITER BONA PROFUNDERE DEORUM EST.

Notes
written by
Benjamin Trench





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of Calcareous Earths

Manner they produce their Effects. I shall give you my own Conjecture upon the Subject tho' the Causes of [&] Fertility of Ground are not properly ascertained. Clays are probably the Basis of all Soils, but are unfit by themselves to support vegetables, without [&] Mediation of some other Bodies to render them properly diffusible in water. putrid Bodies seem best suited to this purpose. for if you expose a portion of stiff Clay to the falling Rains (which are generally replete w: th putrid Matter) it in time becomes readily diffusible in water,

of the Fertilization of Ground.

Shivery in its texture - & an extremely proper matrix for the nourishment of Plants. I suppose therefore $\frac{1}{2}$ Calcareous Earths act only by promoting Putrefaction & perhaps in this calcined state inducing some Change in $\frac{1}{2}$ structure of the Clay since it then becomes a saline Body.

Calcareous Earths are also employed when calcined as Cements in Building.

The workmen find that $\frac{1}{2}$ Cements obtained from Chalk & Limestone are endowed wth different Qualities, tho' on wth this Variety depends we have not yet determined. The Earth ought to be calcined

of Calcareous Earths 3

free from any foreign matter, espec^{ly}:
Other Earths w^{ch} frequently disappoint
us of the Quicklime by various
means as vitrification &c.

The Caustic Calcareous Earth dissol-
ved in water becomes "Lime water," the
so much celebrated medium for dissolving
Calculi of the Bladder & Kidneys. It is
also called *Al. Calcis*, & the liquid Shell.

In order the Lime water is employed
for the purification of Sugars, on w^{ch} it
acts by absorbing the Acid of $\frac{1}{2}$ Saccharine
Juice, w^{ch} otherwise w^d prevent the Gravi-
tation of the Sugar, & retain it in the

of Calcareous Salts.

Form of a Syrup & nd It unites w: th Oil of
the Juice into a Sapo which may be
easily separated by washing.

By restoring the water & sulphuric
Air which the Quick-lime loses in
Calcination, it becomes a Crystallized
Salt or the common Cement for Building
It will appear evident that the Lime
must be in situ, before, Calcination
takes place firmly, or in other words
before the Quick-lime becomes mild.
but as in that state it forms a friable
mass extremely liable to Effluvia when
dry, we must endeavour to obviate
the Inconvenience by the Addition of some

5

of Calcareous Earths

Other Body which is most commonly
Sand. the Effects of which I shall illus-
trate in the following manner. If a
Cubic Inch of wet Clay is exposed to the
Heat or Air, it will contract in drying
 $\frac{1}{10}$ of an Inch, and form a Defect equal
to the Space contracted. But if 100 Cubic
Inches of Sand be added, & the Clay equally
diffused thro' it each portion of Clay will
be a hundred times less than before, and
will consequently form Cracks proporti-
onably less.

Gypsum or Selenites is a crystallized
Salt composed of Vit. Acid & Calcareous Earth.

of Calcareous Earths

Its chief use is to take of the Impressions
of moulds. for this purpose its water is
extracted when like other mineral salts it
falls to powder. But when ^{the} water is
restored it again concretes or swells,
so that the finest lines of a mould are
impressed upon it. The preparation of
Gypsum in large works must be per-
formed in Furnaces. but for private
practice we may employ an Iron pot.
- The Gypsum must be put into the
Pot in Fragments about as large as
Hen's Eggs. Soon after the Heat is applied
it begins to boil; when ^{the} boiling ceases

of calcareous Earth

7

we must remove it from the Fire, be-
-cause the water of the Gypsum is then defi-
-ciated, and if the Fire is continued after-
-wards, a Decomposition of the Acid
takes place. The Figures usually made by
Gypsum are rough on the surface, but they
have lately found that by the addition of
Glue it will receive a polish like marble,
and that by the addition of various Colours
it may be rendered very like marble.

Of Crystalline Laths

These have been called by Authors Tric-
-herent, from their transparency.
- because, tho' very improperly, for they are
not vitrifiable when pure by any degree of
Heat. They are hard eno to strike fire
from Steel - not acted upon by any Men-
- struums - and remarkably fist in ^{the} fire.
Lime. M. Cronstedt divides ^{the} Cryst.
- taline into two kinds 1st the truly Crystalline
- lime or those w^h are not fusible in any
Heat 2nd into such as are to be fused by
Common Fires. of this kind are his
Granates, but as their Fusibility seems
to depend upon ^{the} presence of m. l. alone,

of Crystalline Earths 9

I think they ought not to be considered as a distinct kind.

They are also divided into pure & impure. of the latter sort are common sands, and spars of a particular sort which break into fragments of an irregular shape. of the former are precious stones and crystals, whose shapes are more or less angular, & such as break into fragments alternately concave and convex, as cornelians, agates, common flint &c. When joined wth alkali they become fusible form glass. this ought to be done wth a proportion of

of Crystalline Earths

Earth to alk $\therefore 3:2$. if a greater propor-
-tion of alkali be added it becomes soluble
in acids, and the compound precipitated
is found to be an Alkal. Earth.

Crystalline Earths are chiefly employed
in $\frac{2}{3}$ ^{ch}manufactory of Glap, w. Art is not
even now by any means perfect. You
will see an ex^h of the process in Cramer.
I shall only add that many people have
been mistaken in thinking $\frac{2}{3}$ transparent.
-ry of Glap depended upon the use of cou-
-rleip Substances: for a proper adjust-
-ment of several colours produce $\frac{2}{3}$ most
perfectly transparent Glap. & such as $\frac{2}{3}$
workmen call a transparent Black. —

Of Argillaceous Earths.

11

There have been many Disputes concern-
ing the Division of these Earths. Mr Pott
thinks that there is only One kind &
that the various Species which have
been described, are nothing more than
evident Additions of other matters. we shall
however give the distinguishing properties
of Argillaceous Earths from any other
Clasps. They are never hard eno to strike
Fire from Steel; they are partly soluble in
Acids when dry: they readily Absorb a large
Proportion of water, & acquire wth it great
Viscidit^y: if this mixture exposed to the
Action of the Fire, it acquires a remark-
able hardness. on this Ac^t: they are in

Of Argillaceous Earths

great use among the Potters, & workers
of various kinds of Porcelain & Earthen
wares.

Formerly we were ready to acknowledge,
that the three kinds of Earths we have denoted,
were pure homogeneous Bodies, quite dis-
tinct in their natural properties from
each other, so ² we were doubtful whether
as some Authors have imagined, there
was a primordial Earth the basis of all
the rest: but Mr. Margraaf by some late
Experiments has entirely removed that
Doubt concerning a primordial Earth.
He tells us that Clay is acted upon by many

13

of Argillaceous Earths

And, especially the highly concentrated
Mineral Acid, with the Assistance of
Heat. By such Application he discovers
Clay to be composed of a Crystalline
& such an Absorbent Earth as enters
into the Composition of Alum. in the
Decomposition of Clay by the vitriolic
Acid and the consequent Formation of
Alum I shall observe the following
Circumstances. That the Alum can't
be made by the Addition of vitriolic
Acid & Earth without an Addition of Sal-
-tate, ^{or} tho it ^{occasionally} contains some precipi-
-tation gives rise to the production of every
firm well crystallized Alum. -

of Argillaceous Earths

with Respect to a Primogenial Earth.
we shall Observe, that Clay does not
seem to be such, since it is separable into
the Crystalline & Absorbent. it may
therefore be a Subject of Enquiry whether
Absorbent & Crystalline Earths are
not Clayes composed by some means
or Other? - M. Margraaf informs us
of the following curious Fact, that Water
by Evaporation & Vaporation is converted
into an Earth composed of Crystalline &
Absorbents, & is perhaps a fine Clay. M.
Margraaf says also that by repeated Distilla-
tions the Sediment of the water becomes

greater. Clay w: a proper addition of
 sand & calcareous sub: is extremely proper
 for making Crucibles. —

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34/ 17
of water

We shall now consider the 5th Class of
Bodies, ~~and~~ viz: water, and refer you for
a general Definition of it to ² Objects of
Chemistry. —

Some have supposed that water is chiefly
supplied to the Earth by the precipitation
of vapours exhaled in form of Rain on ²
Tops of Mountains. This w^h it filtrates
breaking out in Fountains Brooks &c.
Others suppose ² the Atmosphere supplies
the surface of the Earth with a very small
proportion of its water: but that water
continue to filtrate thro' the various strata
till they meet wth Subterraneous fires w^h

of water

drives them back in form of vapour ^{or} w:
rise till they are condensed by ^{the} mountains
as it were by Alembics. I am inclined to
think that ^{the} former Opinion is nearest to
Truth, because in opening mines I am
informed that they are seldom interrupted
w: water, after descending below ^{the} common
Level where Rain water penetrates.

From whatever source derived,
water in passing thro' numerous strata
is frequently impregnated w: various sub:
stances.

When waters are so strongly impregnated

Of Mineral waters

as that we may refer their Smell or Taste to
 Other Bodies they are called Mineral, be-
 - cause they are most commonly impreg-
 - nated wth Min^{er}al Substances. but when y^e
 Matters are of such a Quality or in such
 Quantity as not to become Objects of
 our Smell or Taste the waters are called
Common. or such as we use for innum-
 - erable ~~various~~ purposes in life. -
 Independant of any foreign matter adhering
 water is only of one kind, this by no means
 a pure Elementary Body, as some have
 supposed, since it is convertible into
 Earth under a particular Inclination. -

of Common water

Common water as Obtained from Foun-
tains is never entirely free from foreign
Matter adhering more or less. When we
cannot distinguish the Matter present
by the Taste or Smell we must then have
Recourse to Other Tests. When they ~~are~~^{are}
impregnated w: Earthy Matters we may
precipitate them by the Addition of Alkali;
- of w: Acids by the Addition of Solution of
Silver in Nitrous Acid. But Sugar of Lead is
far the most perfect Test, since it will
cause Precipitation in water on w: y:
Other Means produce no Change. The
Specific Gravity of water has been pro-
- ved by some as the most perfect mark

Common water

21

of its purity, but is erroneous since the weight of water depends upon $\frac{2}{3}$ Quantity of Air present.

M^r. Margraff finds that Rain water known at a considerable Height in $\frac{2}{3}$ Atmosphere is equally pure wth. Any that can be obtained by repeated Distillations: it is entirely free from all foreign matters, but always retains a putrefactive substance of Animal & vegetable Origin.

Exactly similar to Rain water is $\frac{2}{3}$ of Snow & Hail, only that the latter contain much less Air, nor can we discover the frigorific Salt wth. Some

of Common water

have that peculiar to them.

Lakes are less pure than any waters of the Atmosphere. The waters of Lakes are very pure, because they are generally supplied by rains from the sides of Hills which have not filtrated thro many strata. They also are purified by the subsidence of putrescent matter, which usually forms the mud usually covering the firm foundations of the beds of Rivers & Lakes. That water is very speedily purified appears from the short time in which Rivers regain their purity after receiving the Discharge of Filth from

of Common water

~~neighbouring~~ populous Cities. We may generally determine the purity of water by the Distance at w^{ch} it issues from the common Height of the adjacent Hills.

of Mineral water

Physicians & Chemists have frequently attempted to investigate ^{the} properties of Mineral waters, & the Cause of those properties. But as most of them (for want of Chemical Knowledge) either have not known w^h Bodies were truly fopile, or w^{ch} of the fopile Substances could be united wth water in a separate Compound State, their Labours have proved in general very unsuccessful. This is the Case of M^r N^o 1.

of Mineral waters

of Dublin & his Countryman Dr Lucas
who ^{is} w. much Arrogance has attempted
to correct his work. I shall give some
general Observations on this subject,
that you may be assisted not only in
discovering the Faults of others, but also
in correcting them by your own Experi-
ence.

Mineral Springs are generally divided
into the Aridula & Therma. The first name
is applied to all Springs sensibly im-
pregnated w. ^{the} fossil matter of any kind,
the Impropriety of which is evident. The
Therma are distinguished on Acc² of the

of Mineral waters

that which they always discover. This curious Phenomenon of the Heat of Springs in the Effect of a Cause not easily investigated. Some suppose ⁴ in running over inflamed Pepites they become hot, or that this Heat is derived from subterraneous Fires; but as many waters have preserved a constant Temperature of Heat for upwards of a thousand years, it is improbable that any Quantity of Pepites sh^d be so long inflamed without producing a Change either in the Direction or Temperature of ⁵ the water. Neither do we observe ⁶ the

of Mineral Waters

Effects of Subterraneous Fires are invariable, and always permanent as in volcanoes &c. Others imagine; the Heat is produced by the Impregnation of such Bodies as generate Heat in solution. But we often find Streams of such purity, as not to be sensibly impregnated wth any Matter whatever.

Such Waters only are called Mineral. Others are impregnated wth toxic Bodies; but we find any other except when a stream is continued along the surface of the ground to some distance. The reason of this seems to be ^{ly} by a particular Economy

of Mineral waters

of nature all Animal & Vegetable substances are converted into fossil substances. After they are washed to a certain depth in the Earth. —

In our inquiries after such fossil Bodies as impregnate Min. waters, we shall proceed in the usual order beginning w: ^{the} _{q:} Saline.

Amongst ^{the} _{q:} kinds none can be reckoned properly fossil productions, except the Vitriolus Muriaticus. The Vit. Acid so universally dissolves or corrodes Fossil substances, ^{that} we rarely find it separate in water, except when suddenly washed out after a decomposition from some

Of Mineral waters

Other Substances. The Pyrites of Coal mines
often dilate when the Air is admitted
and the bituolous kind by ^g means is some-
times washed out by ^{or} means w. happens to
flow thro their Cavities. Another Case
happens when we

waters are seldom impregnated with
the Mineral kind in a separate state,
tho very frequently combined w. th Common
Salt, and fixt Ammoniac. M. Cronstedt
also informs us th the latter is very
rarely found in Mineral springs. —

of Mineral waters.

29

Fist. veg. Alk: is entirely excluded from
the fossil Kingdom. If it has been at
any time found in $\frac{1}{4}$ Bowls of the
Earth its Duration. this is very short &
it would soon probably have been con-
verted by the Action only of the Earth into
a Fossil Alkali. hence we may con-
clude that Min: waters are never impreg-
nated either w: ^{the} veg. Alk: or its Compounds.

The Fossil Alk: is very frequently found
in Min: waters, both in a separate
compound state, but more frequently
in the former than has been imagined.
In the latter state it is found united with

of Mineral waters

Exalts into Common & Glauber's
Salt. The Spurious Salt of Glauber
composed of Ox & Magnesia often
impregnates Mineral water than the
genuine Neutral, and has therefore
been frequently mistaken for $\frac{1}{2}$ true Sal
Glauber. Volatile Alkali never exists
separately or formally, in $\frac{1}{2}$ Exalts King.
down, not but $\frac{1}{2}$: it may be produced
from Min. water in consequence of their
containing Itapar Sulphuris, which by
a properly conducted Distillation always
gives out a vol. Alkali.

We must take Care in reading Authors

of Mineral waters

not to be misled by Terms. Thus Dr.
Short says he found Nitre in almost
 every mineral spring. but he has
 mistaken it for the spurious fac Glauc.
 ber. Dr. Hill has also mentioned
Alarip tum which is nothing more ^{or}
 Potrite alkali. —

Oils both animal & vegetable are
 exposed upon the surface of $\frac{1}{4}$ Earth, tho
 we have never discovered them in the
 Bowls thereof, & consequently not in
 mineral waters. Naptha, or Petroleum
 Oil frequently flows out on $\frac{1}{4}$ surface of
 Springs, & is sometimes combined wth them.

Of Mineral waters

intimately, as Essential Oils are combined
w: distilled waters. Naphtha is sometimes

combined w: ^{the} Sopite Alkali into a Soap
& forms w: are called Saponaceous waters

Sulphur alone admits of no Union with
water, and tho it is sometimes very
minutely diffused therein, yet when the
water is at Rest, the Sulphur subsides

it often unites w: ^{the} Sopite Alk: into a
Repar, & then becoming soluble, it pre-
-sently imbregates Min: waters.

Taste & ^{Odour} ~~Colour~~ of Repar Sulph: is so very
diffusible, that from sub Springs we
appear to perceive very strongly im-
-bregate

of mineral waters

we often cannot obtain one grain in substance, and only discover its presence by the Taste, Odour, and Change of silver after Immersion Mercur. waters then never contain Sulphur except as Super-
th w: it we often find Sal Glaus: & Sal Com-
 = mine.

Among the variety of M. P. very few impregnate Min. waters: partly because few of them are soluble in ~~of~~ water, partly because many of them are not soluble in Fossil Acids, & partly because when they are dissolved they are liable to Precipitation by other matters ^{wh} are diffused thro' ²⁷ earth.

of Mineral Waters

Of all the M.S. except Zinc Copper & Iron are most strongly attracted by acids and ^{are} also the most frequent Metalline productions of nature. Thus therefore we may expect to find most frequently present in waters, and of these two, the latter because it is more generally dispersed thro' the Earth. & most strongly attracted by acids. They are never found except in a saline state. Iron may be combined w. ^{the} acids, Alkalies, or neutral Salts, but most frequently w. ^{the} first; yet it is so difficult to collect Green

35

of Mineral water

Vitriol in its proper form from Min. waters
that some have denied ^{the} existence of
Iron in a saline state.

The Difficulty may be removed by con-
sidering that the Acid of green Vitriol,
is in a vol. state, so y^t When Vitriol
is exposed to the Air it very soon loses
its Acid, & degenerates into an Ochre.
It has been long found y^t ^{Chalybeate} Min. waters
have a certain vivifying Spirit by keeping,
the properties of w^{ch} are not exactly known.
There is ^{it} not sulphuric Acid which exalts
wth the volatile Acid? —

The Mineral water of Copparan by

Of Mineral Waters

no means so frequent as the Chalybeate,
which depends upon Reasons already
given. Naturalists have supposed y:
the Copper is never present in a saline
State, but I have a Specimen of pure
blue vitriol collected from a Spring in
Britain. the Difficulty of Obtaining
blue vitriol in a Crystalline form as
we said of Green gave Rise to y: Susp:
-ion of its Abundance entirely from Min:
waters. the Only M.S. remaining w:
we can expect to find in Min: waters is
Zinc.

This is readily soluble in Acids. - pres.
-cipitates

of Mineral water

Iron & Copper from Or, and is now found to be a frequent production of nature; and yet Chemists alledge: it is never found ~~for~~ in Min^r: waters. It must be acknowledged y^t its presence is rarely discovered. Tho I have seen a Specimen of white vitriol from Mine water. We are led here to enquire ^{to} is the reason y^t Zinc is so rarely present in Min^r: waters? Perhaps it is because Lapis Calaminaris & Luda Galena are not easily soluble in Acids, or rather because we never suspect it

of Mineral Waters

in waters. But do we not not hesitantly?
proper means of discovering its presence.
— By treating the Residuum of Min^l water
¹² w: Copper as in making of Brass we
might always determine whether Lime
is present in any State. —

Earths are found more or less in all
waters, and none more frequently than
the Species of Absorbent. Calcareous¹²
¹² w: are not soluble in water except in
a state of quick lime, are frequently
found suspended in water probably
by solution, since Exposure to the air &
several Additions cause a precipitation.

of Mineral waters

of Earth which never happens in Diffusion.

- From this Phenomenon we are led to enquire in w^h manner it is rendered soluble? - perhaps by a very volatile Acid which escapes unnoticed: but then the precipitated Earth would retain some Marks of Corrosion. - perhaps it is in the form of Quicklime: but if this is the Case how can we imagine ^{the} the Calination had been effected: this however is the most probable Supposition: and if found to be true it will confirm the Opinion that Lime water acquires its Taste & Odour only from an Impureness contracted in

of Mineral waters

burning: since these waters are entirely
without that peculiar taste & Odour
may not Soluble Alk: dissolve in wa-
-ters dispose them to dissolve Earths w:
Otherwise they could not affect? - These
Kinds of waters are called petrifying, be-
-cause by insinuating themselves between
the Pores of Bodies over which they pass, they
dissolve their Earthy particles, & by that
means produce Petrifications.

Crystalline Salts as they are not
Soluble in Waters are never found in
waters except in such small Quantities
as not to form Mineral water, And when

of Mineral water

These small portions are in a state of Diffusion only. —

Argillaceous Earths im-pregnate waters as they are partially soluble in acids: but these are most frequently in a diffusible state. From the extremely minute Diffusion of w. Clay an error has arisen the mistake of Argillaceous Earth in water for truly Saponaceous waters. We have already said y. water is convertible into an Earth ~~so~~ composed of the Abundant Crystalline which are also the Ingredients of Clay. There may not all the clay upon Earth

of mineral water

have been formed thus from water?

See formerly mentioned 3 species
of Absorbent Earth viz: Calcareous
Magnesia & Earth of Alum. These may
be united wth the Lopide acids into Earthy
Salts tho' we are only acquainted wth
one Combination of the Muriatic. Vit.
Acid, & Calcareous Earth produce Sil.
netes. This is a frequent Reduction
since it is very generally the Cause of
hard waters such as decompose Soap.
They are to be remedied by $\frac{1}{4}$. Addition
of fixt Alkali. Vit. Acid & Magnesia
form the Spurious Salt of Glauber, w^{ch} is

of Mineral waters

Abundantly more frequent than the genuine neutral. They are also often mistaken for each other. Earth of Alum uniting wth the vitriolic Acid is often found in the Bowels of the Earth, & may therefore impregnate min. Waters: yet it is rarely found because its Attraction to Acids is weaker than the other Absorbents, than Iron, or Copper. The Combination of calcareous & mar. Acid mentioned before is called fist Ammoniac. This is seldom found alone, but frequently accompanies Corn. & Glaub. Salts. The following is a Table of all the Bodies wth impregnate min. Waters. —

Table of Mineral waters.

Aqua minerales simpliciores.

ex

Salinis

1^{ra} *Alkali Fossile.*

2^{da} *Mercurio a. Sal. Glauberi & sal. marinus*

Inflammabilibus

1^{ra} *Oleum Fossile.*

2^{da} *Sulphureis.*

Metallis

1^{ra} *Ferro*

2^{da} *Cupro*

Terrestribus

1^{ra} *Calcareis*

2^{da} *Argillaceis.*

Table of Mineral waters

Aque minerales Compositae

ex

1^o Salinis variis } Because we seldom find
water impregnated with
Glauber's without common
Salt adhering & vice versa.

2^o Salinis Sulphureis - Hyper Sulph. &c

3^o Salinis Metallinis, bibulis Cupri & Ferri.

4^o Salinis terrestribus. Solentia sal Aluminosa

We shall here subjoin the Table of
Electric Attractions.

Explanation of the Characters contained
in the Table. —

⚡ Acid in general.

⚡⚡ Bituminous Acid

⚡⚡ Vol: bituminous Acid.

⚡ Nitrous Acid.

⚡ Muriatic Acid

⚡ Ac: Acid

⚡ Acid of Borax.

⚡ Acid of Tartar

⊖ Alkalies in general

⊖ fixt Alkali

⊖ Caustic fixt Alkali

⊖ volatile Alkali

⊖ Caustic vol: Alkali.

○ Neutral Salts.

* Ammon^c salts.

△ Phlogiston.

°° Bils in general

°° Essential Bils.

△ Sulphur.

▽ Alcohol.

△ Other.

met.

△ Precious Metals. M.

○ Gold.

○ Silver.

△ Base Metals.

♀ Copper.

♀ Tin.

♂ Iron.

℥ Lead

℥ Mercury

℥ Regulus of Antimony

℥ Zinc.

℥ Bismuth.

℥ Cobalt.

℥ Nihil.

℥ Platina

℥ Arsenic.

℥ Absorbent Earths.

℥ Quick lime

℥ Mag. alba.

℥ water.

℥ Mephitic air.

49

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℥ Lead

℥ Mercury

℥ Regular of Antimony

℥ Lime.

B Bismuth.

K Cobalt.

N Nihil.

P. platina

S Arsenic.

∇ Absorbent Earths.

∇ Quick Lime

M Mag. alba.

∇ water.

Δ Mephitic Air.

[illegible]



49

Remarks on the Table.

It is doubtful whether this ~~A~~ be right placed.

III. By the Figures (1-404) it is understood that the first four Spaces of the two first Columns are to come first.

¹III. This is pretty universally agreed upon by all Chemists except Dr. Lavoisier who has endeavoured to correct it by Experiments.

- for this Reason I have added ²III repeated according to his Determination. perhaps Dr.

Lavoisier is mistaken th w. regard to Platina, for all Chemists say that this Substance has

no Relation to ϕ . But Platina is often united th w. Iron, and ^h y^e Circumstances might

mislead him. M. Margraf has given us some

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49

Remarks on the Table.

It is doubtful whether the ~~V~~ be right placed.

III. By the Figures (1-404) it is understood that the first four Spaces of the two first Columns are to come first.

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united wth Iron, and y^e Circumstances might mislead him. M^r Margraf has given us some

Remarks on the Table.

Experiments ² very much disturb the Column of O . he finds that tho' Z precipitates Copper in the Cold, yet in Heat the contrary happens. perhaps this depends upon a principle that Heat increases the Action of Bodies when separate, but diminishes it when they are combined.

VIII. This is a new Inquiry & an extremely useful One. Dr. Alston for preserving Water at Sea proposes that a Quantity of Lime should be thrown in. This gives it the Properties of Lime Water in which state it will keep for Ages. When it is to be used he directs that Magnesia sh^d be added. This

Remarks on the Table.

is soluble in water, but furnishes Air to $\frac{2}{y}$.
 Lime, w: then falls to the Bottom w: it, and
 leave the the water pure. I place M. S. up:
 foremost because the Addition of mild calca:
 rious Earths restores them from Calces to
 a Metalline Form. —

IX. I have put the $\circ\circ$ and $\&$ together, for
 I do not know whether there is any difference
 in their Attraction to Or. Balsam of Sulphur
 may be united wholly w: Or into a Loach.

XII. I have not given a detail of the
 Liquids in this Column; tho they are in the
 same Order as in the 9th & 10th Column no.

XIII. This stands as given by Geoffroy.

Remarks on the Table

But it is most doubtful of all, and you see the two next Columns are Exception to it.

XIV. Possibly $\circ\circ$ - may in like manner come in with γ .

XVI. Perhaps this is not well founded, tho' agreeable to common Experim. I rather think the Column sh^d stand thus

γ
α
\circ

XVII. This shows that the α only takes the water that enters into mixture wth it in order to Crystallization, and that when it has acquired γ and in a mild state then γ will precipitate α from γ .

XIX. This Character $\circ\circ$ stands here for

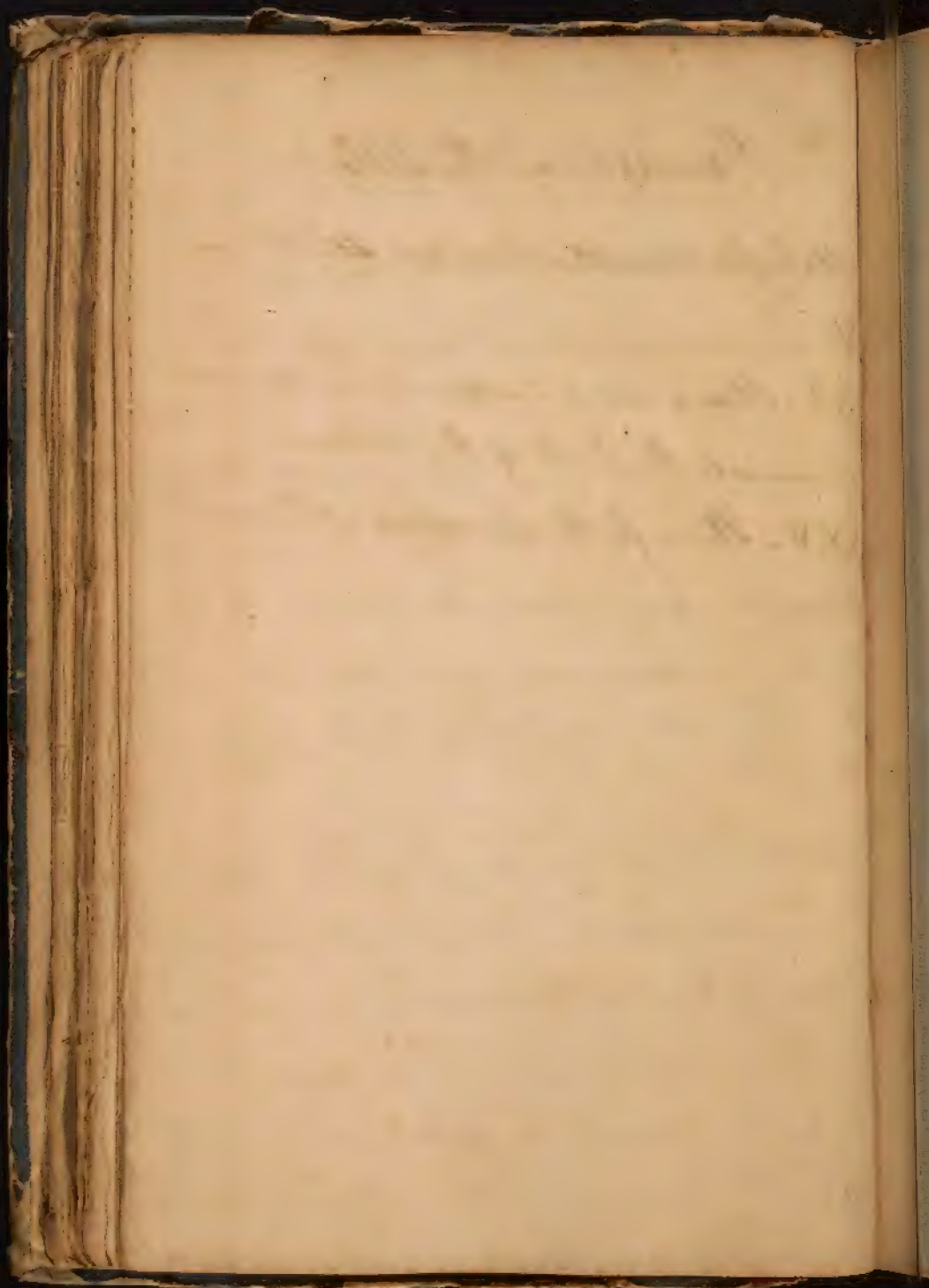
Remarks on the Table

all inflammables that are soluble in

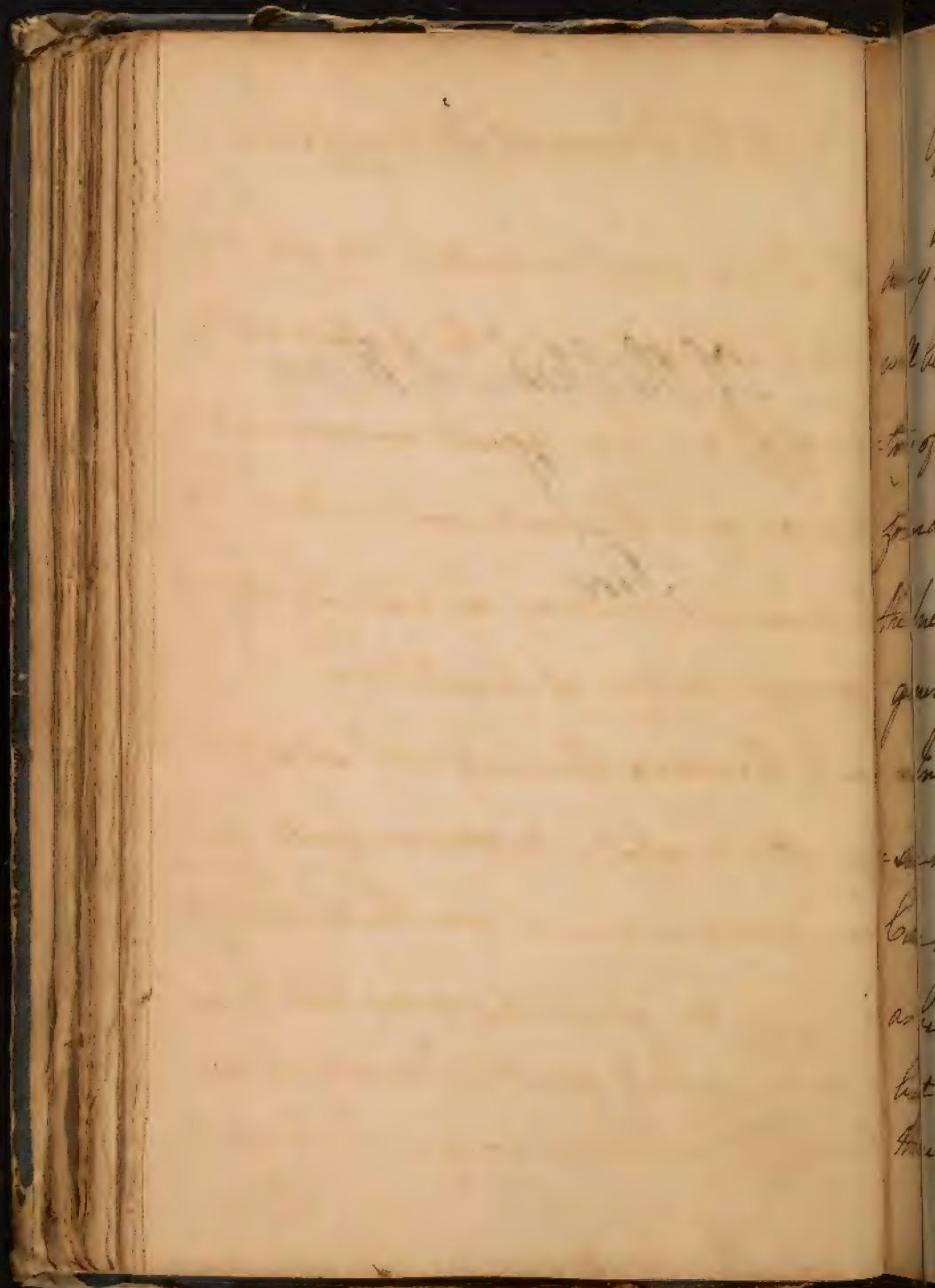
V.

XXII. I have not ascertained by my own
Experiments the Truth of this Column.

XXV. This is for the Separation of Tin and
Silver. —



*Of the Chemical History
of
Fire*



59

Of the Chemical History of Fire

All y^r. we can undertake to deliver,
will be something of the natural His-
tory of Fire: an Agent universally
found, and the most important to
the present purpose, as leading to the
general History of Qualities.

In treating this Subject I shall per-
sue the Analytic Method entirely; taking
Care not to advance new Theories, or such
as being ill-grounded may lead to Error,
but to collect & digest in proper Order
those Facts which have any Relation to

of Fire

The Business in hand. perhaps now
I think I shall reason on some Facts
(for this is extremely allowable) I did not
perhaps a few unexceptionable ones
in general however I shall only enu-
merate known Facts; and then as they are
relative 1. to the Generation of Heat
2.nd its Communication & 3.rd as they are
relative to its Effects.

we shall first treat of 1.st Generation
of Heat. —

Of the Generation of Heat

It may be expected that I should here
give a Definition of Heat or Fire.

but this is very difficult, & perhaps not
to be attempted by ~~me~~ ^{me} w: success till

after a full Induction of Facts. it is

only necessary to premise here y: by fire

here we mean that power w: excites y:

vibrations of Light and Heat. these are

usually joined together, a certain Degree

of Heat producing Light, and this in a

certain proportion Affording Heat.

Some Philosophers in y: Subtle Rea-
soning have agreed y: the term Genera:

of the Generation of Heat

Generation is improperly applied to Heat. for say they, Heat is only collected from heated Bodies, being thus communicated by Bodies to each other, hence they conclude that no Heat can be properly said to be generated. Again Heat always endeavouring to restore itself to an Equilibrium will be equally diffused from a heated Body to a number of similar & contiguous Bodies till all of them acquire equal Quantities of Heat & hence if one Body be more heated than the Rest, it will

of the Generation of Heat

lose so much of it that as is sufficient
to restore an Equilibrium between all
the Bodies. But if by any Continence
Heat can be produced in One Body without
diminishing it in Another, surely in
that Case we may say wth propriety:
Heat is generated.

The means of producing Heat in Bodies
are various. the first I shall treat of
is the Increase of Motion excited in any
Body, to w^{ch} some have altogether refer-
red the Increase of Heat. This is effected by
Mechanical means & is therefore called

Of the Generation of Heat

Mechan. Generation of Heat. It is produced either by Attrition, Percussion or Collision. Altho' these may in some degree appear to be the same, yet it is requisite here to consider them separately.

1. Attrition or Friction. common Experience informs us that by this means a heat may be excited between two solids so as to produce Flame. we may here observe as it is not foreign to our purpose that no Heat can be produced by Attrition in Fluids. - The Heat which occurs in burning seems at first

of the Generation of Heat

light to prove ^e contrary. but we
 must consider y^r in these as well as
 many other cases the Heat produced
 is owing to a chemical Decomposition.
 therefore till it is proved y^r simple ho:
 homogeneous Fluids can be rendered
 hot by Agitation I cannot allow y^r.
 they are capable of producing Heat. we
 find also y^r ~~also~~ Solids produce a greater
 Degree of Heat as they become firmer, &
 are further removed from a fluid state.
 - thus Stone produces more Heat than
 wood, & Metals still more than either.

of the Generation of Heat

the next circumstance for determining
the Quantity of Heat to be produced in any
Body, is the Roughness of its Surfaces
applied & moved on each other. by this
means they impinged cause Oscillations
- one more or less frequent in proportion
to the number of ~~brillations~~ Prominences
- this admits of Demonstration: for as
the Surfaces of Bodies become more
polished less Heat is produced in them
by a given Quantity of Friction. -
Mechanics find that a Gudgeon
of Steel will turn much easier in
a Brass. than a Steel Corset.

67

of the Generation of Heat

According to Muschenbroek's Experiment?
They differ also in the time of acquiring
Heat, and have diff: Quantities of Ex-
pansion in the same Degree of Heat: it
is not easy to say whether this Difficulty
of Motion happens because of Attraction
of Iron to Iron is stronger, or be-
cause the Inequalities of Iron are
better adapted to the same Metal than
to those of Brass. we may likewise ob-
serve that when Iron is employed a
Degree of Magnetism is acquired, & hence
the parts worn off by still adhering con-
tribute sooner to the grinding away of a

of the Generation of Heat

Guidon in an Iron than in a brass
Locket. But as we seldom or never
can obtain a polish so perfect as in
-kindly to prevent the Generation of Heat
it is necessary to interpose some substance
capable of filling up all Inequalities
of the Surfaces. The most effectual for
this purpose are Oil and Black Lead,
^{or} w^h last may be reduced to an exceeding
impalpable powder.

The Roughness of Surfaces, & the hard-
-ness of Bodies being given, the Degree
of Heat will be proportionable to the
Impetus applied, & this again depends

of the Generation of Heat

upon the Quantity of Matter & Velocity
of the moving Body. Velocity increases
the Momentum, & accumulates the
Vibrations by w^{ch} they become more
dense, or a greater Heat is generated.

This may be proved by pulling a Rope
slowly, & then very rapidly thro' a Body:
it will be found that the Degree of Heat
in the latter Case will be most conside-
rable. Here a Question may be ex-
amined, whether the Increase of Cur-
rent increases the Heat produced? It
certainly does in some measure, as
the Centers of Oscillations are increased

of the Generation of Man

in number. The Rule to be observed
perhaps is this, that Increase of
Surface does not compensate for Diminution
of Velocity. for if the Edges, are
thinner the Sides of two broad thin Bodies
be rubbed together wth a given velocity,
Heat produced will be greatest in $\frac{1}{4}$ Plate
than in $\frac{1}{2}$ Plate: but if the velocities in each Exp^t
be reciprocally proportional to the
Surfaces applied, the heat produced by
the Edges will be far $\frac{1}{4}$ more considerable
than the contrary therefore to these undemon-
strable Experiments Mr Martin in the
Edin^{burgh} Med^{ical} Essays alleges $\frac{1}{4} : \frac{1}{4}$ & Deviation
of the Arteries is continued to in

of the Generation of Heat

disperse the Heat equally thro' the whole Body, the extent of Surface in this Experiment is unchanging for a slower motion.

The next Proposition I shall lay down is, ¹y. A Body must be fixed in Order to have Heat produced by the Friction of Another. This may be confirmed by various Experiments. ²y. if a piece of Iron be fixed in a Vice in Order to be filed, or a Rope be pulled rapidly thro' a fixed Block, we shall find ³y. a great deal of Heat will be excited in the fixed Bodies, while ⁴y. moveable

of the Generation of Heat

have no heat but w^t. they receive from
being in Contact wth the heated Body.
If both the Bodies be moveable the
Force applied by the moving Body w^{ill}
be chiefly spent in causing y^e motion
of the whole, and not in producing
Oscillations. Hence it is plain y^e Heat
cannot be produced by the motion of
Fluids on Fluids because Fluids
cannot be fixed. This Conclusion is further
proved by Observing y^e a Fluid interposed
between two solid Bodies prevents the
Generation of Heat. in Answer to this
however several Objections are adduced.

of the Generation of Heat

As the Heat produced in Fermentation;
 But this is certainly owing to a Decom-
 position of parts, and is therefore foreign
 to the present Inquiry.

As Arguments Arg: "This Opinion it is
 alledged that Quick Silver agitated in
 a trial, and a Cannon Ball discharge
 both acquire considerable Heat. I
 grant that Heat is produced in both
 Cases, but at the same time I must
 observe that the Instances are by no
 means conclusive. for in the first
 Case the Mercury is agitation is chang.

of the Generation of Heat

into a solid powder, w^{ch} being rubbed
Agst the sides of the Phial will con-
-sistently produce Heat. in ² 1/2 seconds
Because the Bullet is surely heated
much by in passing from ² 1/2 Gun
violent Attrition Agst its sides & by
the Inflammation of the powder.
Hill therefore it is proved y^t ² 1/2 Bullet
grows gradually hotter from ² 1/2 time
it is discharged from the Mouth of the
Cannon, we attain Conclusiones
be drawn from the Fact. upon the
Whole we may conclude that no Part

15
of the Generation of Heat

can be generated in Fluids by any Mechanical Motion, & hence ^e Absurdity of the Theory by which Animal Heat is supposed to depend upon ^e Attrition of the Fluids Agⁿ: each other, & Agⁿ: sides of the vessels. It is further to be observed th w^t Respect to the Mechan^e Generation of Heat, that it depends rather upon the State of Aggregation than ^{of} ~~upon~~ mixture; and particularly ^e it does not depend upon ^e Quantity of Phlogiston contained, except when we desire to excite Actual Flame, & then ^e Body containing most Phlogiston is to be

of the Generation of Heat

shown. Thus Stone by Attrition affords more heat than wood. This wood contains by far the largest Quantity of Phlogiston or inflammable Matter. This takes place even in different kinds of wood. E.g. Mahogany is capable of more heat from Attrition than any other wood, Altho' they may contain more Phlogiston. We may make the same Observations on m.S. - Iron is capable of having more heat excited than Lead, & indeed it has more inflammable Matter. But Lead contains more Phlogiston than the

of the Generation of Heat

Iron is far less capable of Heat, Friction. The Quantity of Heat produced therefore depends in a great measure upon the Hardness of Bodies, & consequently on the State of Aggregation, and not of Mixture, except so far as the latter influences the former.

Thus then we see it is from ^{the} Quillations produced in any Body that its Heat is generated. These Quillations are supposed to be excited in a very Subtile Fluid, interposed between the particles of all Bodies, ^{as} from Sr Isaac Newton who tho' not the first Discoverer was ^{the} first

of the Generation of Heat

Author who treated the Subject fully has
been called 2^d Newtonian Opinion.

That such a Fluid exists is at present
the generally received Opinion. it is not
convenient for me now to enter far into
the Dispute. I shall only Observe that
upon existing Motion in any Body
a new Subtile matter seems to be intro-
duced at its pores. now Altho this is very
probable; yet it must be Objected, that
if it was really true, the same Motion
sh^d. produce Heat in proportion to the
Number of contiguous Bodies. This
however does not happen. neither is

29

of the Generation of Heat

The Heat of the surrounding Bodies diminished. in Electrical Experiments the Matter is collected & accumulated in one Body without Diminution of it in ^{the} rest from w^{ch} it is derived. These Arguments however are not conclusive: nor can anything be determined wth certainty till a method is found of stopping the propagation of Heat as we do that of Electrical Matter. Here a Question occurs that I shall propose without attempting to answer. Whether on ^{the} common Hypothesis that Heat does arise from the Influa of a subtle Matter, is ^{the} Heat excited in this Matter owing to Oscillations?

Of the Generation of Heat

It may indeed be remarked yth Fire
its Matter is common to all Bodies
without Respect to them as Mixts.

The Agency of Fire is so very extensive
that the Explanation of it requires par-
-ticular Attention. in Order to do this,
the several Facts relating to y^e Subject
ought to be collected: but this is ad-
-vanc^d few are either willing or able to
accomplish. Therefore of the many Hy-
-potheses w^{ch} have been formed I shall
only mention the three principal.
The 1st of these Opinions is, yth the Heat
of Bodies depends on Motion, & one

Of the Generation of Heat

Particular Modification of this motion.
 This was first started by Lord Bacon &
 followed by Isaac Newton who says in
 a Query at the End of his Opticks that
 Light, and Gross Matter are mutually con-
 verted into each other.

The 2.nd Opinion is that Fire depends
 upon motion, but that this motion can
 be obtained only in one particular species
 of matter contained more or less in all
 Bodies. This is followed by 4 foreign
 Philosophers.

By the 3.rd Hypothesis Fire is supposed to
 depend upon motion peculiar to the

of the Generation of Heat

Subtle Radii Filid Alone, ^{ch} w: we called
formerly the Newtonian Ether. This
the Opinion most generally received,
& w: seems to be best confirmed by the
Experiments relating to ² Mechanical
production of Heat by Attrition.

nd II. of Percussion. This is ² second nd Mechanical
Means of producing Heat, by
^{ch} w: is meant chiefly hammering. it is
for the most part applicable only to
Metals. Stones, Minerals, & perhaps
woods not admitting it upon ² Au: of nd y:
Fragility or weakness of Texture.

For the production of Heat by percussion

of the Generation of Heat

Two things are necessary 1st firmness
of Cohesion in Opposition to Fluidity
or Fluidity. 2nd a quick Repetition of
the Stroke. Thus Iron may be hammered
till it is red hot.

That the Body to be heated must be fixed
in this Case, as well as in y^e Case of Attri-
tion appears from several Circumstances.
E.g. the striking Hammer being move-
able is almost cold, tho' a piece of
Iron be beaten wth it on an Anvil
till it is almost red hot. Again when
a Nail is driven up to the Head in a
piece of wood, so that it can be forced no
further, a few Strokes will render it

Of the Generation of Heat

very hot; whereas many Stones will not have the same Effect while it continues to move.

From all ^{y^e} has been delivered upon this Head, it appears that ^{y^e} Heat generated by Percussion is owing to a Tremor or Oscillation excited.

IIIrd of Collision. This is the third Mechanical Means for generating Heat. I shall attempt an Explanation of this, tho' it is an extremely difficult task. Collision is a slight Stroke of two Bodies agst each other, chiefly of M^d. Stones & long balline substances, not as being better adapted for it by any particular

of the Generation of Heat

Quality in consequence of their mixture,
 for Argillaceous Earths may be suffic^t
 hardened by Art to produce the same Effects.
 It is surprising to see the Degree of Heat
 produced by so slight an Impulse. it has
 being sufficient to fuse even Iron w^{ch} is
 among the Bodies of the most difficult
 Fusion. nothing ~~is~~ is more difficult
 to explain than this Phenomenon in
 the whole Theory of Fire. we shall however
 observe y^t at every Stroke a small
 particle of the Body flies off. This does not
 happen from the Force of y^t Stroke, but
 from the Vapour Fluid accumulated at

Of the Generation of Heat

Heat ^{is} place w. by its expansive force
throws off the particle. Something like
this happens in Bologne Bottles ^{is} w. are
made without Amalgam. for if a bullet
be dropped into ~~any~~ one of these, it
will not fracture it. but if a piece of
Glap or any such Angular sharp substance
be employed, the Bottle will be
immediately shivered to pieces.

The ready breaking of thick Glap
results upon the sudden Application
of Fire cannot be accounted for, but
by the Accumulation & Expansion of
the Subtile Ether as in the former Case.

Of the Generation of Heat

The Inference drawn from the foregoing
 Experiment relating to Glass, may
 be further illustrated by recollecting
 that Glass vessels are able to bear a
 very considerable pressure ^{& ch} w: maybe
 broken to pieces by a very slight stroke.
 And upon the whole tho' as I said before
 it is extremely difficult to deliver any
 thing complete upon the Subject of
Collision, yet one maybe observed
 to confirm ^a ~~our~~ ^{general} Relief of our
 general Proposition ^{ie} that there is
 an Elastic Fluid in all Bodies more or
 less according to their State of Aggregation,

of the Generation of Heat

"And that by exciting Friction or Compression in this Fluid, all mechanical Generation of Heat depends".

Fire being already considered as produced by mechanical Means, is now to be treated as generated by γ Mixture or Combination of various Bodies. Here the chief Difficulty in γ Theory of Fire arises: for in Cases of mixture γ Heat does not seem to depend upon Motion, but on the different properties of γ Substances to be combined.

Before we proceed to particulars, it will be necessary to lay down a few general propositions.

87
Of the Generation of Heat

1. All Chemical Combinations pro:
duce either Heat or Cold greater than
either Body contained before mixture.
we must however Observe ² the Degree
of Heat or Cold cannot be always ascer:
tained. for as the Change of Temperature
in Bodies, is increased proportionably to
the Quickness, & some other Circum:
stances of the Union; so when these
Circumstances are any way abated, the
Change of Temperature becomes in pro:
portion less Obvious to our Senses. thus
in the Solution of Selenitic Salt in water

of the Generation of Heat

Only a few Grains are soluble in a
Pint, & a considerable time is required
for performing even this Solution.

It is a very necessary tho' laborious

Task to enumerate all such Combina-

tions. Many have attempted this, &

have enumerated prodigious Numbers

of Mixtures. M^r. Muschenbroech for the

Instance reckons more ⁿ 300. & upon

4^e plan w^{ch} he followed he might have

reckoned several hundred more. This

Superfluity arises from an Ignorance

of a proper Chemical System. I have

made the following Table upon a

Of the Generation of Heat

different plan. than I will not pretend
to say are faultless: but only ⁴ they
under this part of the Subject less intricate
cate to the learner, than ² perplexing
numbers of combinations enumerated
in some others.

I shall first give you a Table of
the heating, & then of ² cooling mixtures,
& after each a few general Remarks
on the several Articles. —

Table of the Heating Mixtures.

I Acids th w: Alkalies

— with neutrals containing Or

— with Soap & Resin Sulphuris

Metallic & Earthy salts w: Soap & Resin Sulphuris

Sulphur with Alkalies

Ammon: Salts w: fixt Alkalies

Metallic Salts w: fixt Alkalies.

Ammon: Metallic & Earthy Salts w: neutrals.

II Acids th w: Oils.

— w: Animal & veg: Bodies

Ammon: Metal: & Earthy Salts w: Oils, & oily Bo-
= dies.

III Acids with Alcohol

Metallic Solutions w: Alcohol yth Attracts yth Acid

IV. Acids th w: Metallics

— w: Metallic Salts

Sulphur w: Metallics.

Neutrals th w: Metallic Salts.

Table of the heating mixtures.

Common: Metallin & Earthy Salts w: thMetallin.

V. Acids w: thEarths.

— w: thEarthy Salts.

— w: thAnimal & vegetable Substances.

Sulphur w: thEarths

Common: Metallin & Earthy Salts w: thEarths.

VI. Acids w: thwater & watery Liquors.

— w: thAnimal & veg. Substances.

— w: thAir.

— wine w: thwater

Metallin Solutions w: thwater & thprecipitates them.

VII. Acids w: thAcids.

VIII. Alkalies w: thInflammables.

IX. Alkalies w: thMetallin.

X. Alcohol w: thReg: $\frac{1}{2}$.

XI. Alcohol w: thwater & watery Liquors.

— w: thAnimal & veg. Substances.

— w: thSolutions of Salt.

Table of heating mixtures.

XII. Mercury w: thmetallies.

XIII. thmetallies w: thmetallies.

XIV. water w: thCalined Salts.

— w: thdilaguenent Salts.

Remarks on the Table.

Article I

Vol. Alkali has been long tho't to ge-
nerate Cold w: thAids: but later Experiments
proves the contrary. for if thrown in to wa-
ter it generates Cold. w: thconcentrated
Aids it generates Heat. now if the
Aid employed be very dilute, the Cold
generated by the water w: it contains may
be greater than the Heat generated by the
Aid, or they may be so proportioned as
precisely to counteract each others Effects,

95

Remarks on γ heating mixtures.

by that means produce no Change of Temperature on the Addition of the Alkali, & hence the Foundation of this erroneous Ancient Opinion. if the Alkal. is in a caustic State more Heat will be generated than if it was mild. The other Heads of this and indeed of all the other Articles do not produce this Effect except when a Combination takes place.

Article III. This is properly made a separate Article, for tho' some Mixture of Alcohol is a Composition of Oil & water, yet the Oil does not exist formally in it, and γ Heat generated is greater than that of Acid wth simple water.

Remarks on $\frac{2}{4}$ Table of heat & fire

Artic^{le} VI. The water must here be supposed in a State of Fluidity.

Article VII. It is rather doubtful whether the Heat here produced depends upon the Action of Acids on each other, or on the water which they contain. I think the former the most probable Supposition, because a tertium Quid is produced, & the Heat generated is greater than $\frac{2}{4}$. A small Quantity of water contained in concentrated Acids could be able to produce.

we shall now proceed to the Table of cooling mixtures. —

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Tab

Table of cooling mixtures

- 1 Acids wth Bodies exhaling much vapour.
- 2 water wth Crystalline Salts
— — — with Ice.
- 3 Ice wth Saline Bodies.
- 4 Ice with Alcohol.
- 5 Alcohol wth Ammoniac Salts.
- 6 Alcohol wth Oil.
- 7 Oils with Oils.
- 8 Alcohol wth Soap & Aepar Sulpheuris

Of the Generation of Cold

99

Remarks on $\frac{1}{4}$ Table of Cooling Mists

Article 1.st Acid applied to vol: Alkali^{ch} generate heat. but the Inhalations^{ch} of Acids arise from the Additionⁿ to this Alkali in a compound State overcome by their Cold the Heat otherwise generated.

Art: 2.nd The combination of Ice and water is extremely curious. for if the water be heated to 50° : & the Ice at 32° : the Thermom^r: will sink to 32° : during the Solution.

Article 5.th Perhaps this Article might have comprehended wth propriety all the Crystalline & Deliquescent Salts.

After this general view of $\frac{1}{4}$ heating

of the Generation of Heat

A cooling mixture, it will not be improper to add some general observations thereon. in the first place these Tables contain all $\frac{1}{2}$ Chemical Combinations in w^{ch} any Change of Temperature can be observed.

In the Combination of Earths & Metals the Change of Temperature cannot be observed, because a very intense Heat is required to unite them. the Generation of Heat always happening upon these Chemical mixtures is extremely difficult to be precisely determined. it chiefly depends upon $\frac{1}{2}$ proportion of $\frac{1}{2}$ matters

of the Generation of Heat

added. Thus Sal Armon^c may be dissolved
in water in the proportion of one to three,
and if less of the Salt is employed a pro-
portionably lesser Degree of Cold will be
produced. Heat is most effectually & most
plentifully produced when the mixture
is done at Once, & not at several In-
tervals, & hence the means of expediting
the Union of Bodies are to be employed
when we would obtain the greatest Heat:
as for Instance performing the mixture in
Open Air or in vacuo, according as it
takes place more readily in One than the
Other.

To Obtain the greatest Degree of Cold

of the Generation of Cold

Let a Superabundant proportion be
employed of the Body producing Cold.
Here a Question arises Whether by combi-
ning a large or small Quantity, more
Heat or Cold is produced than is propor-
-tionable to ² Quantities added? From
own part I can find no great Difference
~~Let~~ because the Heat or Cold communi-
-cated to the whole Bulk is in proportion
to the Quantity required. we may some-
-times perhaps Observe more Heat or Cold
in a large Quantity: but this happens

of the Generation of Heat & Cold.

Because such Bodies are a longer time
 time in acquiring & losing Heat than
 smaller. Heat & Cold produced in a way
 of mixture encrease in a certain pro-
 portion whatever may have been
 their Temperatures before mixture. thus
 Or and first Alk. generateth mixture
 100^o of heat more than Ordinary, say:
 if they were heated to 40^o before mixture,
 they would on being united produce 140^o:
 if to 60^o: they w^d produce 160^o Degree of
 Heat, & so on in the same Ratio. This
 Observation is applicable to $\frac{1}{4}$ cooling

of the Generation of Heat

Mixtures. when a Body ^{ch} w: we desire to freeze contains a considerable Degree of Heat, it is very difficult to reduce it to the freezing point, because the Mixture applied must be much below that point. Thus if the freezing Mixture at 26: ^{ch} is 6: below ^e point, and the Body to be congelated be at 40: no Freezing can be Obtained, for the intermediate Degree between these two viz: 36: is above the freezing point.

From considering this Subject it appears that the Notion of Calorific

Of the Generation of Heat

and Frigorific particles is without Foundation. for these Effects do not arise, or at least are not inseparable from any peculiar Matter: the same Bodies being capable under proper Management of producing either Heat or Cold by the same Operation.

Thus water poured upon calined Nitre produces Heat & crystallises it; and if the Addition of water is still continued it produces Cold.

of the Generation of Heat.

Ice & water differ only in their State of
Aggregation, & yet produce Opposite
Effects: nor can these Effects arise either
from the Absence or Presence of Phlogiston.
Since acids and water Substances the
most uninflamable produce Heat,
while Alcohol & Oil w^{ch} are remarkably
inflamable produce Cold. even when
Phlogiston is present, & in some mea-
: sure influences the mixture, the
Heat or Cold produced are by no
means proportionable to y^e Quan-
= tity

of the Generation of Heat

thereof. for Instance Heat produced
by the Combination of Acid & Metals
is equal to, or perhaps greater than
that resulting from a mixture of
Acids and Oil. from w^h has been
said then Our Proposition will appear
true "that the Change of Tempera-
ture induced depends on the State of
Aggregation"

Acids become the Basis of numerous
heating mixtures from their great
Affinity to Other Bodies. being almost

of the Generation of Mass

universal Menstrua. before we proceed further it may not be improper to constitute an accurate Distinction between Mixture & Solution. by Mixture the Substances loose their peculiar Properties, & form a tertium Quid. by Solution the Substances possess the same Properties as before except y^t they are changed in their Form of Aggregation. Thus Alcohol thrown into water is changed in its Feature and

Of the Generation of Heat

reduced to a fluid State. still however retaining its particular Qualities; but if joined ^{to} w. And the properties of both become entirely changed, & a neutral will be produced differing in quality from either. Mixture takes place in a certain proportion of $\frac{1}{2}$ Ingredients, beyond ^{which} w. either may be added without $\frac{1}{2}$. Effect of Mixture; tho' by adding a superfluous quantity of $\frac{1}{2}$ Solvent a Solution may be Obtained. in Mixture only two Ingredients, in Mixture

Of the Generation of Heat

many may be combined at ^{the} same time. in some Cases of Mixture this Observation may appear not true. 2.^d It may be objected that the three Ingredients Acid, Phlogiston & Alkali are required for ^{the} production of Hepar Sulphuris, but then let it be Observed that ^{the} Acid & Phlogiston must be united before a Sulphur can be formed. ^{1st} afterwards uniting wth ^{the} Alkali produces a Hepar. Indeed if ^{the} Objection takes place here, it may also

111

Of the Generation of Heat

be admitted Ag: w:ry Combination.
for in none of them are pure Elements?
parts employed. There is also a considerable
Difference between Solution and
Mixture in their Decomposition. for
in Order to decompose Bodies combined
by Mixture, greater Heat is requisite
than w: have volatilized them in a
separate State. Whereas if Bodies are
united Only by Solution, that Degree of
Heat w: would volatilize them in a
separate State, would also volatilize y:

Of the Generation of Heat

From when ~~separate~~ dissolved. Thus from
a Solution of neutrals y^2 : Superfluous
water may be readily exhaled, while
an Intense Heat is required for the
Dissipation of that portion necessary
to Crystallization. Upon the whole
I think we may conclude y^2 : When
mixture takes place Heat is generated,
when Solution Cools. Those Cases in
w^h: Heat & Cold both happen will
be readily understood from an atten-
-tive Consideration of y^2 foregoing

of the Generation of Heat

Tables. we may also conclude ^{ly} in
 these Cases Heat is produced by Motion.
 as in the Mechanical Generation.

Much however depends upon ^{the} Manage-
 ment of the Air 1.st Cold may be produced
 by the rarefaction of ^{the} Air as we may
 prove by the Air-pump. 2.nd Cold may
 be produced in Bodies by restoring them
 first Air to an Elastic State. or 3.rd Cold
 may be produced by converting Bodies
 into Vapour.

These Experiments are very useful.
 would be more so if the Convenience of them

of the Generation of Heat

could be exhibited: but this can be done in the first Instance Only, in which an Increase of Heat may be perceived by restoring Air to an exhausted Receiver, or Again Airs or Alcohol combined with water shew an Increase of Heat & a Diminution of Bulk from Condensation. we may Observe by way of Illustration to the Subject, that as an Elastic Cord when it receives a Stroke, has quicker Vibrations according to the Increase of Tension,

Of the Generation of Heat

So in Heat occasioned by $\frac{1}{2}$ Vibrations of an Elastic Fluid, the vibrations will be fewer in proportion to $\frac{1}{2}$ Diminution of Density in that Fluid by the Rarefaction of the Air, & consequently a Generation of Cold may be effected.

We are now to consider $\frac{1}{2}$ Generation of Heat by means of Fermentation.

By Fermentation is here meant every kind of Assimilating process. in all these Heat is visibly produced, but more especially in the three most noted

of the Generation of Heat

Spices, the vinous, Acetous & putre.
- lactive. in the last of which so great
Heat may be produced as to excite acti-
- al & lame. in the Acetous & Heat gene-
- rated is less, & in the vinous least of
all.

Philosophers in general think Heat
is generated in Fermentation by me-
- chanical Means: but they are
certainly mistaken, if we admit y.
Supposition that Heat is not to be produ-
- ced by the motion of y particles of
Liquids Against Each Other. Besides y

of the Generation of Heat

Heat generated is not proportionable
 to the intestine motion. for in the
 various Fermentation there is $\frac{1}{4}$ greatest
 motion, and least Degree of Heat, whereas
 in the putrefactive there is $\frac{1}{4}$ greatest
 Heat, and least motion. I am inclined
 to think from all these Phenomena
 that the Heat in Fermentation depends
 upon a Decomposition & new combina-
 tion. but the whole Theory of Fermen-
 tation is ~~so~~ so imperfect that we
 can deliver nothing wth Certainty
 upon it. —

of the Generation of Heat

We next proceed to consider ^e Generation of Heat in Animal Bodies. a Subject of great Importance, but extremely difficult to be treated in a proper Manner. Heat is Observed to be greatest in breathing Animals, and of those greatest in such as breathe repeatedly. very small Insects may likewise be Observed to have some Heat by applying a Thermometer to a Number of them together. in the same Class of Animals *Ceteris paribus* the Heat is nearly the same. thus in the human Species it is

Of the Generation of Heat in Live Bodies

generally between 90° & 100° . .

It is very difficult to investigate the causes of Animal Heat. for this purpose Authors have formed various Hypotheses, the chief of which I shall enumerate.

1. Animal Heat is supposed to depend upon Fermentation, particularly of the putrefactive kind. That this Fermentation generates heat is beyond a Doubt. nay it is as certain as y:
 such a Fermentation occurs in y Animal Body: yet these Circumstances how:
 = ever

of Animal Heat

Favourable to the Hypothesis are
by no means suff^t to overcome the
Objections that may be raised Agst
it: For 1st we may Observe that the
Putrefaction in living Animals never
rises so high as to produce the Heat
we Observe in them. It may also be
added that tho' Fermentation may
produce considerable Heat in Animal
Bodies; yet this only happens when
it is advanced so far as to destroy^g
Texture of the Body. This Putrefaction is

of Animal Heat

is sometimes Observed in Animal Fluids, tho never except in a morbid State.

2nd Objection is, that Heat produced by Putrefaction is so slow, that it is lost as soon as generated. some indeed imagin that the putrefaction tho slow is constantly kept up by the Food taken in. but I think y^e such Aliment as we take in, is often Anti-septic, i^e according to this Hypothesis t^o tend to the Diminution of Animal

of Animal Heat

Heat.

a³ and a very strong Objection is y² in Inherent Maps y²: Heat is in proportion to the Quantity of matter, Whence we find that in Animals of y²: same Order the Heat is nearly equal tho' they differ considerably in Bulk. for instance we find y²: y² Heat of a Mouse, is as great as that of an Elephant.

These Objections alone seem suff²: to prove the Fallacy of this Hypothesis. Tho' we might add further that y² Heat of animal Bodies is not proportionable

of Animal Heat

to the Degree of Putrefaction. in putrid
Fouls the heat is not so great as in
some of the inflammatory kinds may
be sometimes below $\frac{1}{2}$ Natural Stan-
dard. The same may be observed in
the Scurvy; for when this Disorder is so
violent as entirely to corrupt $\frac{1}{2}$ Ani-
mal Fluids, the Heat is lower than in
many other Cases. Besides $\frac{1}{2}$ that of
putrescent Matters cannot be increas-
ed by extraneous Motion w^h we see
happens in Animal Bodies: but is
rather affected in a contrary manner.

of Animal Heat

4th a still more conclusive Objection is
That Animal Bodies putrefy most
quickly when all the vital Functions
cease, and yet notwithstanding ^e great
Degree of Heat produced here, the Corpse
will be very little hotter than ^e surround-
ing Atmosphere. I think we may
therefore safely conclude: Animal Heat
is not the Effect of Putrefaction.

a Second Opinion is That Animal
Heat depends upon certain Decompositions
& new Combinations going forward in
the Body during Languification: but in

Of Animal Heat

In this Case the Heat sh^d. be proportionable
 to the Quantity of Food, & the Excretions
 performed; and that this is not y^e Case
 appears from such Animals as sleep
 half the Year; for in these y^e Heat remains
 nearly the same during y^e sleeping sea-
 son, tho' they not receive any Alim^t.
 & consequently cannot be supposed
 to lose much by Excretion. if there is
 a Diminution of Heat in these Animals,
 or in a man who fasts for several days,
 it is owing probably to a want of Exercise.
 a 3^d more specious & more generally

Of Animal Heat

received Opinion is y: Animal Heat depends on Motion excited by Mechan: Means. That it depends chiefly upon Motion appears evident from y: Diminution or Increase of heat on y: slower or quicker Motion of the Blood. & to demonstrate in w: Manner Motion produces this Effect, various Hypotheses have been proposed. We have already endeavored to prove the Absurdity of supposing y: Animal Heat is owing to an Intestine or Fermentative Motion of the Fluids. I think the Opinion of those who Attribute

of Animal Heat

it to the Action of the Fluids Ag¹: Each
 other will appear equally groundless
 from the following Fact. if Blood be
 received from the Body in a vessel con-
 taining a Fluid equally warm, by the
 most violent Agitation 2^d: Mixture
 will not receive any Additional Heat,
 but in a short time become cold.

It is more generally alledged 3^d: Heat
 is owing to the Attrition of the Fluids Ag¹:
 the Solids. This Opinion is easily confuted,
 for to the Generation of Heat by Friction,
 the Surfaces sh^d both be uneven, nor

of Animal Heat

Should there be a Fluid interposed be-
-tween them, the Reverse of w: ^{ch} hap-
-pens in the Animal Body. Besides
Neither of the Bodies are fixed, conse-
-quently little or no Heat can be gene-
-rated. Finally the Fluids do not
move w: th sufficient velocity to produce
Heat. This is ^{2d} Argumentum Fou-
-cis w: ^{ch} many have endeavoured to
elude. Some suppose that ^{2d} Increase
of Surface compensates ^{2d} Diminution
of velocity, & upon this D. Martin
founds his more ingenious, than

129

of Animal Heat

useful Treatise. but allowing $\frac{2}{y}$ Diva-
riation, w: $\frac{1}{y}$ Gentlemen mentions
to be equal & proportionable to the Di-
minution of velocity in $\frac{2}{y}$ small vessels,
yet his System may be Overthrown
by the following Observations alone
viz: ~~h~~ That in vessels of $\frac{2}{y}$ same size
near the Heart, and in $\frac{1}{y}$ remote ex-
tremities, the Blood moves w: very
different velocities, the Motion of $\frac{2}{y}$ Blood
tho' the Lungs being to $\frac{1}{y}$ of $\frac{1}{y}$ Aortic
System as 5 to 1 nearly; & tho' in
different parts of the Body $\frac{2}{y}$ Heat

Of animal Heat

may vary, yet upon ^ey: whole from ^ey:
Quickness of Circulation it will be found
nearly equal. Some Other Cause must
therefore be invented to be: for an:
Heat.

Dr Rob^t Douglass fancies ^ey: that is
only produced in its passage thro' ^ey:
Capillary vessels, or such as will
only admit One Globule to pass at One
- Ag: This many Objections may be
brought. He thinks that in such a
Case the vessel & Globule would act
on each Other as Solids. But he does

of Animal Heat

not properly distinguish Friction from Adhesion. Both the Bodies being smooth when applied may have considerable Adhesion, but no Friction, this requiring a Roughness, consequently therefore no Heat can be produced by this means. we may add further than $\frac{1}{4}$ velocity of the moving particles, absolutely necessary to the production of Heat, is here wanted, for the Blood in the Vessels, as Dr Hales has fully proved by Experiment has an extremely languid motion.

Let us now consider $\frac{2}{4}$ Hypothesis by which $\frac{2}{4}$ Heat of Animals is supposed

of Animal Heat

to depend upon the motion of the Blood
thru the Lungs. The Momentum here
has been already given, by what appears
that want of Velocity cannot be objected.
- Thou who endeavour to explode the
Opinion use another Argument viz: That
Heat is greatest in Breathing Animals
whose Lungs are constantly exposed to
the cool Air in Respiration. This Reason-
-ing I shall not attempt to deny letter-
-ly, tho' I imagin^y: Breathing is chiefly
designed to obviate ² Disadvantages ^y:
might arise from too great Heat otherwise
produced in these Animals, and as a

of Animal Heat

proof of this I allege that the ^{air} which
exites by Expiration is much hotter
than that taken in by Inspiration.

Besides we have no Experiments to prove that Heat is either generated or diminished in the the Lungs. for Blood drawn before or After passing thro' y^e Lungs is equally warm. if by any Experiments a Difference can be observed between the Heat of Venous & Arterious Blood, it happens because y^e Latter flows out more quickly, & thereby loses less Heat than the former. upon the

of Animal Heat

whole, I suspect this Theory has but
very little Foundation!

Dr. Bryan Robinson imagined y:
Heat was occasioned by Something
(perhaps he meant an kind) Absorbed
from the Air by Animals, & mingled
w: ^{the} Blood of the Lungs. I differ
from him in Opinion, rather suppo-
sing that Something is rejected from
than taken into y: Lungs during
Respiration.

all these Hypotheses being mentioned
& the Objections to each, I think

of Animal Heat

none of them appear satisfactory. I shall therefore deliver a few Observations ^{ch} w: I do not presume to offer as un-exceptionable, but shall submit them to the candid versions of any candid Inquirer. it may have its use, at least there is no Danger in starting such an Hypothesis, ² & Truth of which is to be examined by Experiment.

As Animal Heat evidently depends Upon, or is principally connected th w: the Moving Powers of the System, so these powers are depend^t.

of Animal Heat

on a subtle Elastic Fluid or Nervous
Power, conveyed to every moving Fibre
by hollow Tubes or Nerves; & in this
Fluid, Oscillations are constantly
excited. The Existence of this Nervous Fluid
after long Disputes among Physicians
is now generally admitted. It is of
such a Nature as proves it cannot
be derived from Secretions, & from the
great Subtility & Elasticity of its Nature,
it may probably have a near Affinity
to the Electric Fluid. I am far from

of Animal Heat

Thinking they are the same. for tho'
 a Subtle Elastic Fluid may be:
 Foundation of Fire, Light, Electricity
 and Animal Heat, yet we must con-
 sider it as very differently modified
 in each of these. I shall not pretend to
 conjecture in w^h manner these Modifi-
 cations are performed. It is eno^{ugh} for
 our present purpose to say y^t such a
 Fluid is diffused thro' every Fibre of
 the Animal Body, & that from an
 Oscillatory Motion continually excited

of Animal Heat

excited in this Fluid, Animal Heat is probably derived. I do not assert this Opinion as a real Truth, nor am I prepared to answer all ^e Objections that may be made agst it. I only offer it as an Hypothesis, w^{ch} not being entirely void of probability may be a Subject of further Experiments and Observation.

we come now to the 5th Means of generating Heat viz by Inflammation. This is commonly

of the Generation of Heat.

Not to be an Instance of Communication,
 but improperly, because the propagated
 Heat becomes greater than in $\frac{1}{2}$ Body
 where the Inflammation began at
 first, and the Heat in this last Body
 is not diminished by this means. in
 consequence of Inflammⁿ a new Motion
 is excited, and every particle or Spark
 of the inflamed Body becomes as it
 were a new Centre of Brillations in
 each of which a Motion is also excited
 in every Direction. in these Cases only
 does the Phlogiston of $\frac{1}{2}$ Chemists

of ~~the~~ Inflammation

appear necessary to the production of
Heat. Inflammation depends upon
a peculiar Affection of this, or upon its
being converted into vapour. Thus
Other tho so readily inflammable
may have a burning Coal plunged
into it without being inflamed, when
- as if the Coal be held in the vapour
arising from the Other it will immedi-
- ately set it on fire, the subtle Liquid
sh (to take an example from a Spring
coiled up) being then let loose. we
may now I think Review ^{the} Safety

of Inflammation

That the Collision of two Elastic Fluids
 is absolutely necessary to the Inflammation
 of these Fluids. Phlogiston must be
 one, and Air is generally the Other. but
 as far as we are capable of judging, the
 Phlogiston being being any other Fluid
 will act w:th it so as to produce Inflammation.
 for example water converted
 into vapour will answer this purpose.
 - the Action of the Air I shall con-
 sider more fully hereafter. Bodies may
 be inflamed by the action of the Air

of Inflammation

without immediate application of burning
Steel. This appears evidently in
Sulphur if violently heated, or in Oil,
but more especially in $\frac{2}{3}$ burning
Phosphori.

Certain Bodies are liable to, and
Others incapable of Inflammation. There-
fore it must require a peculiar mat-
ter. here a question arises whether
Inflammation depends upon Bodies
as mixts, or whether it is essential to
some Elementary Bodies? I rather
favour the former Supposition, be-
cause

of Inflammation

we know y^t in every Inflamⁿ an Acid
 is present, w^{ch} is not inflammable as
 Oil. Sulphur. Alcohol &c. here must
 be some other matter requisite.
 This the Chemists call Phlogiston, and
 they imagin it is an elementary matter
 of itself inflammable. here however
 I differ from them, for the Acid seems
 to have as great a Share in the
 Inflamⁿ as the Phlogiston. This Phlo-
 giston then of the Chemists I suspect to
 be sulphuric Air, which we find arises
 from all inflamed Bodies, & enters

of Inflammation

Sometimes into their Composition,
as in the Vinous Fermentation. In.

Inflammation seems to consist in
the Resolution of this Compound in
the Air; may so necessary is Air that
every individual particle must be ex-
posed thereto. on this principle alone
can we account for the Effects of y^e Blow:

pipe. Common Air therefore is
absolutely necessary to Inflammation,
that is for the Resolution of Phlogiston
which it does chiefly by Attracting-

of Inflammation

uncting ^{the} ~~the~~ and destroying ^{the} ~~the~~ peculiar properties of its mephitic air. This mixture however like all Others is limited: and w: ever more is added of either will be kept in Solution, & consequently will not lose its peculiar Properties. hence it is evident if any means can be invented for Attracting ^{the} ~~the~~ mephitic air more strongly than ^{the} ~~the~~ surround^{ing} Atmosphere, a less Quantity of common air would suffice, by the Assistance of such means for a given length of time, for the purposes of Respiration & Inflammⁿ.

of Inflammation

This means was invented by D. Haller.
he found that $\frac{1}{4}$ same Quantity of Air
which served an Animal to breathe for
two Minutes, would serve $\frac{1}{4}$ same Ani-
mal eight or ten Minutes by $\frac{1}{4}$ Interpo-
sition of Cloths dipped in Causticist
Alkali, w^{ch} has a very strong Attraction
to first Air.

Phlogiston therefore is a Mist com-
posed of Mephitic Air, and an Acid, w^{ch}
by Inflammable, is resolved or decom-
posed. it acts chiefly by means of the
common Air which Absorbs $\frac{1}{4}$ first Air.

of Inflammation

147

For if this was not the Case we sh^d see
the Effects of Mephitic Air either inext-
inguishing Flame, or destroying
Animal Life.

Inflamⁿ is universally situated in
the Vapour of Bodies. I. g: if a Candle
be extinguished, & bro't near to a
burning Body, the Flame will ~~be~~
again renewed, tho' the Bodies be kept
at some Distance from each Other.
hence also is the Expiⁿ: applicabl^e: we
lately cit^d, of plunging a burning Coal

of Inflammation

into Other. on these principles are
founded the machines for extinguish-
ing Fires - They contain a small
Cask of Gun. powder w^{ch} is again en-
closed in a Cask of water. when the
powder explodes, the Force of it blows
out the Flame & at the same time dis-
perses the water w^{ch} prevents y^e fire from
being immediately rekindled. From w^h
has been said it appears that y^e Subject
of Inflammation is a vapour arising

of Inflammation

from certain Bodies; that the vapour
must be raised before Inflammation
can take place - that this vapour
is the Phlogiston of the Chemists com-
posed of an Acid & Mephitic Air. - y
Inflamⁿ consists in the Resolution of
this Phlogiston & the Absorption of $\frac{c}{y}$
Mephitic Air by y Surrounding At-
mosphere; and upon ^{the} whole we may
conclude y Inflamⁿ is an Instance of
the Generation of Heat by Combination or
Mixture. that the Mephitic Air here

of Inflammation

mentioned is a part of the Phlogiston
appear from its Effects. The Acid is
not so very obvious: yet it may be
demonstrated in some Cases, particu-
larly of the burning Phosphor ⁱⁿ w^h have
all an Acid for their Basis.

This is all I think necessary to be said
upon $\frac{2}{4}$ Subject of Heat generated by In-
flammation. Something however
still remains to be said concerning the
production of Light, w^h may be consid-
ered as a different Modification of the

of Light

same Matter that produces Heat, &
 ided is has such a near Affinity to it,
 that they may both be comprehended
 under the Term Fire. I shall not deli-
 ver more upon this Subject than an
 Enumeration of its several Divisions.
 To the 1.st Division we may reduce such
 Bodies as become luminous by being
 exposed to the Light of Others. Such after
 being in the Light a few Minutes will
 afterwards disperse Light themselves for
 several hours. in Accounting for this

of Light

Some suppose y^t such Bodies absorb
Light: but this Opinion is Open to
innumerable Objections. perhaps
vibrations are excited in them^{ch}: remain^g

after the exciting Cause is removed.

This kind are many Substances in na^{ch}

-ture 1st: the Bologna-Stone w^{ch}: was dis-

-covered by an Alchemi^{ch}: philosophico

Proemacher, & found to be nothing but a

Combination of vitriolic Acid & Calc^{ch}: Tart^{ch}

- - 2nd: a German Lawyer discovered a Phos-

-phorus in dissolving Chalk in nitrous
Acid,

of Light

153

and afterwards calcining it. This from
the Inventor was called Phosphorus of
Balouin. all kinds of precious Stones
particularly the Diamond exhibit
this Phenomenon in a greater or
lesser Degree. -

The 2nd Division to be considered com-
prehends the luminous Animals, as
Glow worms, - Moths - Insects in Sea wa-
ter &c.

Under the 3rd Division may be reckoned
the production of light by Putrefaction as
in Fish, wood &c. but this perhaps will

of Light

be found to depend upon Insects.

Under the 4.th Division we may reckon
the production of Light from Electricity, a
Subject so difficult and obscure y^t the
greatest Geniuses of the Age have not
been able to investigate it clearly.

The 5.th Division comprehends the
Light produced by Mercury in vacuo.

This perhaps is only a Species of the
Electric Light. I must observe that this
Experiment will not succeed if the Vacuum
is very perfect.

I do not chuse to enter further upon

of Light

this Subject of the Production of Light.

I only point it out for your future
Inquiries. nor shall I here discuss where

ether Light is a peculiar Matter issuing
from the Luminous Body, or only a par-
ticular Modification of the Ether.

is so generally diffused thro' nature,
but I shall hasten to y^e next part of
our work after concluding from w^h:

has been said, that Heat consists in y^e
Motion of a particular Matter w^h is

present in all Bodies, but does not form

of the Communication of Heat
a part of this Mass as Mists.

This part of our Subject tho^y
most interesting, & most connected w:
practice has hitherto been least culti-
vated. in treating upon it I shall
endeavour to lay down a general
enumeration of the different Laws which
take place in y: Communication of
Heat, sometimes adding a few
Remarks.

Law 1: ⁱⁿ The Communication of Heat
is common to all Bodies, & all Bodies

of the Communication of Heat

will impart & receive Heat from all
Other Bodies: and this Communication
of Heat will continue till all surround-
ing Bodies attain the same Degree of
Heat.

Remark. This shows $\frac{2}{4}$ expansive pow-
er of Fire, th is always endeavouring
to recede from its Center. $\frac{2}{4}$ Action of $\frac{2}{4}$
Sun is the most general Source of Heat
from whence Supplies are derived for
the use of that which is constantly flying
off. Heat every where exerts a repulsive
& expansive power, without showing

of the Communication of Heat.

any tendency to be attracted by particular Bodies. As a consequence of the Equality of Heat in all Bodies it appears that Fire is common to all Bodies, but peculiar to none; & that if in different Bodies different Degrees of Heat be Observed, this variety is owing to the Difference of Vibrations excited in such Bodies.

— II.nd — The Communication of Heat between two Bodies requires some time, & diff: times are required

of the Communication of Heat

in different Bodies.

III: The Quantity of Heat lost or rec^d.
in a given time is directly as $\frac{2}{4}$ Quantity
of Heat in the communicating, &
inversely as the Quantity in $\frac{2}{4}$ receiving
Body. Thus, if a Body heated to 30° . be
applied to one Body at 100° . & another
at 200° . the heat lost or received will be
greatest in the last case. Again if the
Body at thirty be raised to 60° . the
Heat communicated in a given time
will be greater when it is at 30° . than at
 60° . & vice versa. —

of the Communication of Heat

Law IV: The Bulk of the Body, and the Quantity, & Quality of $\frac{1}{2}$ Matter being given, the Heat lost or received will be proportionable to $\frac{1}{2}$ Surface.

Hence it follows that $\frac{1}{2}$ Figure of Bodies has considerable weight in these Cases. E.g. a given Quantity of Matter will communicate or receive more Heat in the Form of a Cube than if it be moulded into $\frac{1}{2}$ Form of a Sphere.

V. — The Figure, Quality & Quantity

of the Communication of Heat

of Bodies being given, the Heat Vector received will be somewhat proportioned to their Balbs.

Remark. If we suppose an Iron Ball to consist of a number of concentric Layers, Heat communicated to it will pass slower, & slower ~~and~~ from one Layer to another towards $\frac{1}{2}$ Center. Whereas in returning from $\frac{1}{2}$ Center again to the Circumference of $\frac{1}{2}$ Ball, its motion will be performed in a less time, as it passes from one Layer to the greater which surround it.

Of the Communication of Heat

Law VI. Heat passes out of any body
in the $\frac{2}{y}$ greatest proportion at y^2 part
where the Layers are fewest.

— VII. The Surfaces & Bulk of Bodies
being given, they lose or receive Heat
in proportion to the particular Luthi:
his of this matter.

Remark. Machembreich supposes
 y : this depends upon the Density of y Bodies,
& has constructed a Table on this Supposi:
tion. But here y : great Philosophers
certainly mistaken: for Mercury which

of the Communication of Heat

is a Body remarkably dense grows hot
and hot much sooner than water. to

W: Then must we attribute it? - It
depends perhaps upon some parti-

cular Quality not yet investigated
or explained. These Facts lead us

to Observe that there are Conductors
of Heat, and non Conduction of it as

well as of Electricity, tho not so absolute
in the former as in the latter Case.

But sufficient Examinations have
not been made to determine the

of $\frac{1}{2}$ Communication of Heat
Qualities of these, or their exact Effects.
It may be even made a Query whe-
-ther Air or water grow hot or cold soo-
-nest? I imagine however if $\frac{1}{2}$ latter
receives Heat most readily, because
a heated Body cools sooner in water
than in Air. It is Observed $\frac{1}{2}$ all
Fluids & Metals are quick Conductors
of Heat, as well as of Electricity. wood
conducts Heat very slowly. hence $\frac{1}{2}$ use of
wooden Handles to Instruments $\frac{1}{2}$
are often applied to the Fire. —

of the Communication of Heat

If there is any Absolute Non-Conductor of Heat, it is Air; for I think it is doubtful whether Heat is conveyed thro' the Air, otherwise than by heterogeneous particles of it are always diffused therein.

Another Analogy between $\frac{1}{2}$ Heat & Electricity is Wood. This Substance does not convey Electric Matter, & conveys Heat or Cold but very slowly. hence its use in Lamp Furnaces to confine the Heat, & hence its use in Cloaking. I hence $\frac{1}{2}$ Reason why metals feel

of the Communication of Heat

coolest to us than wood tho' both be in the same Temperature may be discovered viz: that the former convey the Heat from our Bodies much quicker than the latter.

When Bodies receive Heat on their Surface faster than they communicate it thro' their Substance, an Accumulation may occur greater than $\frac{1}{4}$ Heat of the communicating Body; thus $\frac{1}{4}$ small wish of a Lamp may very considerably heat a large vessel. This Accumulation however is limited: for when the Heat

of the Communication of Heat

Flowing off from γ Surface of γ receiving Body, is equal to that received from the receiving from the communicating Body, any further Increase of Heat ceases.

Bodies cool faster in γ Air than they otherwise would do, because there is

a continual Change of Air on their Surface, occasioned by the rarefaction of the Air contiguous to, & the greater Density

of that at some Distance from γ burning Body. we may therefore conclude γ :

Air is no more a Conductor of Heat than of Electric Matter. Water collection in

of the Communication of Heat

Large masses preserve nearly ^{the} same
Temperature in very great Changes of
the Air. and this also chiefly depends
upon the Force of Gravity, for when the
water on the Surface becomes condensed
by the Cold it sinks & is succeeded by
a warmer portion: this being acted upon
by the Cold sinks likewise, while warmer
water again supphs its place. by this
means it happens ^{that} some of our very
deep Lakes elude as it were ^{the} greatest
freezing power we ever feel in this Climate.

of the Communication of Heat

In the Earth & Ocean likewise $\frac{c}{y}$
 Temperature is nearly $\frac{c}{y}$ same in all
 Climates & in all Seasons if we go to
 a certain Depth below the Surface. to
 determine therefore the Heat or Cold
 that prevail in any part of the Earth,
 we must not only consider $\frac{c}{y}$ Latitude
 of the place; but also the Distance of
 it from the Earth's Center & from the
 Sea Shore. Summers as they are moister,
 are always colder. Winters as they are
 moister are always warmer. Is not this
 owing to $\frac{c}{y}$ Disposition of moist Bodies to
 preserve their Temperature. —

of the Effects of Heat

I shall endeavour to pursue these three
their several Stages beginning w: ^{the} Expansion
- down.

Expansion of Bodies is demonstrable
in the ^{the} lowest Degree of Heat w: w: we
are acquainted: for we cannot see:
- any in any Body in its utmost State
of Condensation; therefore all Bodies
are liable to Expansion. Bodies ^{of} 4:
are homogenous & of 4: same Strues
- there are expanded every way equally
by the power of Fire. Fluids generally
suffer a greater Expansion from a

169

of Expansion

given Degree of Heat than Solids.

This Expansion is visible in many Fluids, and upon this depends the Construction of very useful Instruments called Thermometers.

As the proper Application of these is often extremely useful in Medicine, as well as in all the Branches of Experimental Philosophy. I think it will not be improper to enter in to a full Diffusion of them, endeavour^{ing} at the same time to point out the

of Thermometers

Fallacies & Inaccuracy ² may occur
in their use or Structure.

of the Construction of Thermometers

For this purpose we choose Bodies
that are most readily affected, or (as
I shall use the Expression hereafter) most
sensible of Heat. Such Bodies (as we
have said before) are Fluids. There is
one Disadvantage attending ^e use
of them, namely that they will
only measure Heat to a certain
Degree, before they are converted

of Thermometers.

into vapour. This Difficulty however is
pretty well Obviated by the Calculation
^{or} w. Sir Isaac Newton proposed.

The Fluids most generally employed
are Air, Alcohol, Bil & Mercury.

Air has several Advantages as
being very sensible of Heat and very
expansive. But its Expansibility
is so great, that it almost impossible
w. any Convenience to have a Scale
long eno for measuring y^e Changes
that occur in the Atmosphere.

of Thermometers.

It is also liable to be affected by the variation of Density in $\frac{e}{y}$ Atmosphere. from w: has been said therefore it appears y: Air-Thermometers are only fit for transitory Experiments, and for such perhaps it is better adapted than any Thermometers yet invented.

Alcohol, when used for Thermometers is ~~instructed~~ th w: Cochineal, that its motion in the Tube may be rendered more Ob-
servable. It is very sensible of Heat, & very expansible, nor will it freeze

173

of Thermometers

but in a great Degree of Gold, yet it will
not show great Degrees of Heat because
its boiling point is considerably less
than that of water. upon ^{the} whole
however it may be employed w. great
advantage in many Experiments espe-
cially since it will not change by
keeping for a very great number of
years. —

Oil has often been used w. tolerable
Success for shewing the Change of
Temperature in the Air. for this pur-
pose the expanded Oils of vegetables are

of Thermometers

most suitable. Oil boils only in an intense Heat, nor will it freeze but in a great Degree of Cold. but then even a moderate Degree of Cold gives it such viscosity as renders it entirely useless.

Mercury has more Advantages to recommend its use than any other fluid. - It is next to air in Sensibility. it resists freezing more than any fluid. it does not boil except in a very considerable Heat, but on ^{the} contrary

of Thermometers

it is not very expansible, so that it will not require a very large Scale. and consequently will not shew accurately the small Changes of Temperature. It is liable to be rubbed into a black powder by its Motion agst the Sides of the ~~Tube~~ Tube; it will calcine before it arrives at its boiling point, thereby fouling and stopping up the Tube. upon the whole it appears that a Mercurial Thermometer is the best to be used.

of Thermometers

as a Standard, for shewing the Changes
of the Atmosphere & for great Degrees
of Cold, but should never be used for
determining Heat greater than that
of boiling Water. —

The larger the Bulb of a Thermometer
be in proportion to its Stem, & greater
will the Scale be, & the Expansions
more evident: but then as ^{the} Bulb be-
comes larger, its Sensibility becomes
less. The Glap of w^{ch} the Bulb is com-
-posed should be blown as thin as is
consistent wth its Safety. It would

of Thermometers

also be better to make it in ^a form of an Oblong or Oblate Spheroid, than in the form of a perfect Globe. Since by this means more of the Surface of the contained Fluid will be exposed to the Action of Heat or Cold, & consequently (by Law 4.th) more Heat or Cold will be received, that is ^a Sensibility will be increased.

On the Uniformity of ^a Cylindrical Tube depends in a good Measure the Perfection & Accuracy of the Instrument.

When the Fluid is put into ^a Tube, it ought to be as free as possible from

of Thermometers

air, but any of the Air separating
should divide the Fluid in $\frac{1}{2}$ Scale.

When the Tube is filled to a proper
Height, we are generally directed
to extract the Air, & then Seal the
Tube Hermetically; but Mr. Wilson
an ingenious Gentleman at
Glasgow who makes $\frac{1}{2}$ most perfect
Mercurial Thermometers. says $\frac{1}{2}$
the Air tho' left in the Tube does not
sensibly counteract the Expansion
of the contained Fluid, and $\frac{1}{2}$ the

of Thermometers

Weight of the Air does not sensibly affect the Motion of the Fluid in the Tube.

of the Graduation of Thermometers

A Scale divided into any Number of equal parts may be applied to the Tube: but unless in this Case some general Rule is to be followed, we cannot compare the Observations of Others ^{to} our Own. Two Standard points have therefore been fixed on, ^{as} are the Degrees of Heat in boiling and

of the Graduation of Thermometers

freezing water. The most easy and exact method of getting the freezing point is to put the Thermometer into melting Ice or Snow; for tho' $\frac{1}{4}$ water may seem to be above $\frac{1}{4}$ freezing point, yet as long as the Snow or Ice is dissolved, so long is the water at the freezing point, & accordingly the liquor in the Tube depressed to that point. -

The boiling point of water sh^d. be determined at a middle State of $\frac{1}{4}$ Atmosphere, when the Mercury in a Barometer stands at Inches 29,5; for when $\frac{1}{4}$ weight of the Atmosphere is less, there is less

Of the Graduation of Thermometers

Pressure on the boiling water, & $\frac{1}{4}$ Lin
quor in the Tube will not rise to 212: is
is the boiling point on Fahrenheit's Scale
& vice versa.

The Application

When we desire to ascertain very exactly
the Degree of Heat or Cold in any Body,
Care must be taken to apply the
Thermometer for some time $\frac{1}{4}$: all
possible Heat may be communicated
from the Body. Otherwise we shall be
often deceived. as for Instance, it
has long been a desideratum to

of the Application of Thermometers

determine the exact Degree of Heat in
a healthy human Body. Fahrenheit
has marked it at 95: Others at 98:
and an ingenious French Philosopher
has lately informed us ¹ it should be
computed at 100: or upwards. -

of Fluidity

183

Having said ^{end} on the Subject of Expansion, I shall proceed to consider the next Effect of Fire viz Fluidity. Most solid Bodies in a certain Degree of Heat become fluid. Most fluid Bodies in a certain Degree of Cold become solid. if therefore any Exceptions occur to these general propositions we must conclude that it is owing to our Deficiency in applying a sufficient Degree of Heat or Cold. The only Fluid ⁱⁿ which we cannot render solid by Cold is Air, ^{the} which Altho it resists the greatest Cold we can employ when alone, yet in Combination

of Fluidity

it may be easily rendered solid.

Solidity & Fluidity do not depend upon the form of the physical Elements of Bodies, as some have imagined, but only ^{the} State of Heat in different Bodies; and therefore as the Form of Heat or Fire consists in Motion, so the Solidity or Fluidity of Bodies depends upon Heat or Motion.

I am conscious that many Objections may be opposed to this Doctrine by those who imagine that Fluidity depends on a certain Globular Figure of the ultimate particles of Bodies, ^{which} enables them to roll easy over each other.

of Fluidity

on the least Impulse, & that on the contrary the particles of Solids are fitted and angular. They suppose likewise that the freezing of water ^{is} is the most common Instance of the Conversion of a Fluid into a Solid. depends upon some Saline or frigid particles, which enter the water and entangle ^{its} ~~the~~ Globules. The Arguments in favour of this Hypothesis are fully drawn up by Mr. Murkenbrach, ⁱⁿ w. I shall here enumerate & endeavour to obviate each by

of Fluidity

my own Observations. -

I: It is said that water converted into Ice is expanded, this therefore cannot be the Effect of Fire but of some new Matter introduced.

Answer. Water converted into Ice yields a Quantity of Air, which it contained in its fluid State, & this being in some Measure enveloped therein, as appears from $\frac{1}{4}$ Bubbles in any piece of Ice, renders it lighter, & at the same time expands it. as

of Fluidity

a further Illustration of this we may observe that water congelated After its Air has been separated by an Air pump is less expanded, & its Specific Gravity greater than usual. -

II. It is said y^t water may be observed to freeze at the Side first where y^e frigorific particles enter; nay Machinbreach says y^t he has seen them enter in a kind of Stream at y^e part of the Phial where the Freezing began.

Answer. The Freezing beginning at a certain part of the Phial may

of Fluidity

depend upon ^e same principles as
Crystallization, namely ^t is begun
where the Phial is thinnest or where
the greatest Degree of Cold is applied.
as to the frigorific particles w^{ch} this
ingenious Philosopher believes he saw
entering into ^t part of ^e Phial where
the Freezing began, I have no Idea
how they could be visible to his Eyes, &
at the same time Small eno to pass to
pass thro' the pores of Glass. I rather
suppose that what he saw was Air
separated at the place where the Freezing

began.

III. It is said that water is longer fluid in close than in Open vessels, & still longer in vacuo, because say they the frigorific particles cannot so readily have access to the water.

Answer. Freezing water not only requires, a certain Degree of Cold, but also an Opportunity to discharge its Air, ^{as} it can. It does not do well in vacuo or close vessels, because there it has not convenient Air to dissolve the Phlogistic Air evolved during the Freezing of the water.

I shall here mention a curious Expt.

of Fluidity

that occurs to my memory of w:^{ch} I never
have had a satisfactory An^r. If water
be put into a Phial covered w:th a loose
Bladder tied close to the neck, it will not
congeal in a greater degree of Cold than
the freezing point; but if the Bladder
be pressed down by your hand, it is
immediately converted into Ice if the
freezing Cold prevails in y^e Air.

IV. It is said that water remains
fluid when the Temperature of the Air is
below 32^o and congeals often when it is
above that point. —

of Fluidity

191

Answer. This Fact so contrary to general
Experience cannot be admitted, since the
Experiments have not been made by such
ly attended to the Fallacies to which Ther-
mometers are liable. - from using them
in Chambers - from their being in Con-
- tact wth large Bodies y^e are not suddenly
altered in their Temperature such as the
walls of a House, & lastly from not ob-
- serving the Interval of time between the
Effect produced, & the Examination of the
Instrument. before this Arg^t can be
be established we must find y^e water a

of Fluidity

Thermometer plunged into a water in
its fluid State sinks below 32° . and $\frac{1}{2}$.
When congelated the Therm.ⁿ rises above 32° .
- Mr Mushenbroch does not pretend to
have made these Experiments himself.

V. - The Appearance of Frost & Snow sh^d.
be very uniform: yet in places so near each
Other that no Alteration of Temperature
can be supposed, Frost & Snow are in some
of them as in a State of Frost, in Other con-
=dering a Thaw. -

Answer. Still here it has not Observed
Whether the places where $\frac{1}{2}$. different Effects
were produced were also of $\frac{1}{2}$. same Temperature.
= true

Fluidity.

193

Moisture retains warmth more than dry Air. Hence at the Sea Side no Frost is often observable, when at a little Distance its Effects are very apparent. But in these Cases I have always found a Difference of Temperature by the Thermometer. This may arise from various Circumstances. Besides the mere Temperature of the Air other Causes concur for the congelation of water, the chief of which are the vapour arising from the Earth. In all Cases where this vapour is intercepted, the Snow continues longer than usual even in Dunghills where a greater Degree of

of Fluidity

generally perceived. Dr. Hales on Survey-
ing a Field found only one particular
part of it covered wth Snow below which he
also found a Stone Conduit. I have
regularly Observed the Truth of this Ob-
-servation, that wherever I Observe Snow
melt sooner than usual I conclude there
is a lax porous Soil; - in places where
it remains longer, I conclude the Soil is
hard and rocky. -

VI. In this Argument Mr. Mushenbroch
adduces an Experiment w^{ch} has been
reckoned decisive. if water in a vessel
be put into another containing Snow, &

of Fluidity

both applied to the Fire, the Snow in the external vessel will be melted, the water in the inner will be congealed. The fine particles are therefore driven from the Snow to the water.

Answer. To this we need only reply ^h that the Solution of Snow like other Solutions generates a considerable Degree of Cold, ^{ch} it is not so much diminished for a short space of time, as not to be capable of congealing the water in the inner vessel, provided it is near the fusing point. —

VII. It has been said that Salt put

of Fluidity

round a vessel occasioned a Congelation
by transmitting their Saline particles:
but this Supposition is Overthrown by con-
sidering that many Salts produce heat
from a Combination wth water, and
that they always impede the Effects of
Cold, & render the water more tenacious
of Fluidity. —

VIII. Again, it is said y^t Cold is more
frequent, and intense in places where y^t
Earth is more impregnated wth Saline matter
— and Instance is adduced from Tournefort
who found a greater Degree of Heat
at Paris than at Armonia. But

of Fluidity

197

These Observations prove Only $y: y^{\text{th}}$ Cold
is not in proportion to the Latitude
of the place. There are many Circum-
stances $y: y^{\text{th}}$ may have an Influence on
different Climates $i: i^{\text{th}}$ the Elevation of
the place Above the Level of the Sea, &
have found by Trial $y: y^{\text{th}}$ we may measure
the Heights of Mountains as well wth a
Thermometer as wth a Barometer. There
are certain Heights at wth Freezing always
takes place, & at any place of $y: y^{\text{th}}$ Elevation
Snow always remains unmelted. M^r
Guguet has drawn a Line of congelation
& shown its gradual Defect to y^{th} Earth,

of Fluidity

^{ch} is very useful in this view. 2nd Location
& Latitude being given the Cold is
greater in proportion to the Distance
of the Sea. hence Formfort Observed a
greater Degree of Cold in Armenia ⁿ 4.
at Paris. Edinburgh & Petersburgh
are nearly in the same Latitude, yet 4.
latter is further from the Sea, & accordingly
we find a great Difference of Temperature.

. IX It is alleged that Snow melted differs
from pure Fountain water. Claus
Borrichius found 4. the ^{former} ~~latter~~ would not
answer all the purposes of the ~~former~~
latter. There is no Occasion to refer this
Difference to frigorific particles. the

accurate Margraaf has found $4:\frac{2}{3}$ melted
Snow is harder. But as there is a Difference
between boiled & Spring water from $\frac{2}{3}$ Extr.
-cation of Air from the former so in the
same manner may there be a Difference
between melted Snow & water, as the
latter may be some time in absorbing its
proper Quantity of Air w^{ch} increases its
power as a Menstruum.

X. The Inhabitants of the Alps from
using melted Snow are liable to a Disease
called Gutter tumidum.

Answer. all the Inhabitants who
drink melted Snow are ^{not} Afflicted wth this

of Levidity

Disorder. nor is it Observed in other Mountains as the Andes in America where Snow water is used as freely as on the Alps.

XI. It is said y^e Ice does not increase in thickness according to the Cold; this therefore must be owing to y^e inclusion of frigorific particles by the Ice already formed.

Answer. the Ice resists considerably y^e Communication of Heat. the water likewise being enclosed by the Ice as it were in a vessel cannot evolve its fixed Air.

XII. It is said we frequently observe

of Fluidity

arise, and as an evaporation began to
commence, a greater Degree of Heat
was produced, & in consequence of it a
Congelation.

XIII. The Effects of Acids upon Ice are
not the same as upon water. This must
therefore be owing to some extraneous
matters.

Answer. In innumerable Instances
we find that ^{the} Difference of Aggregation
causes a Difference in the properties of Bo-
-dies without the admixture of any new
matter. from considering therefore the
Discussion of these Arguments you will

of Fluidity

see the Truth of w : we alledge, that the
Freezing & Concretion depend upon a
 certain Degree of Cold, & y : there is no
 Foundation for thinking they are con-
 nected w: any frigorific particles.

There are some Special Phenomena w:
 Regard to the freezing of water w : have given
 Occasion to this Dispute. Thus in some
 Bodies the Change from a solid to a
 fluid State is by gradual & all possible
 intermediate Degrees, without our being
 able to assign the exact period of Fluidity
 & Firmness: water on y contrary passes
 from the one State to the other in a moment.

of Fluidity

Wax is given as an example of the former Change. There are however very few Bodies that do not congeal at a certain time. it has been imagined by some y^d the Concretion of Metals is analogous to y^d of wax. but Reaumur has shewn y^d it is more ~~at~~ analogous to water; and in the ^{Pr^t} of wine & several oily Bodies the Concretion is as sudden as that of water. The Cause seems to be this. There is always in water a certain proportion of Air at a certain Degree of heat in a fixed State. if the heat is diminished the power of the water is

of Fluidity

a menstruum is diminished, & so a
 Quantity of the Air is set free. ^eFluidity
 of the water seems to depend in a great
 measure upon the pressure of fixed Air so
 that as soon as it is extricated by a suff.
 Diminution of Heat the water becomes
 solid.

The same thing happens to all other
 Bodies liable to a sudden Contraction. ^e4:
 French Academicians who went to Lap-
 -land found the Spirit in their Thermometers
 suddenly frozen & raised higher than before
 it expanded by the fixed Air extricated &
 restored to a fixed State. Reaumur found

of Fluidity

also in Metals, as for example Iron
that they also expanded at y^e Instance of
Concretion: owing to the Vascularity retained
to the extricated Fluid as before. -

You see then the great probability
Fluidity depends upon Heat. why this
Cause operates so unequally depends upon
peculiar properties in Bodies which have
hitherto been unexamined & unexplai-
ned. —

of vapour

The third general Effect of Heat is the Conversion of Bodies into vapour.

The vaporation of Bodies may be considered as of two kinds 1st the Solution

of different Bodies in a State of vapour

2nd the Conversion of Bodies to vapour

When every particle repels another, and becomes as it were the Centre of an Elastic

Atmosphere. -

The Solution of Bodies in vapour seems to be the Cause of several Phenomena, particularly the Ascent of water of water from the Earth in a State of

Of vapour

vapour, ^{the} we certainly for the most part depends on Solution. Nothing is more certain than that water Absorbs Air and fixes it, & again that Air carries off water, & volatilises it. The Air like other menstrua acts in the Solution of water according to its Dryness, Heat & Density. And if this is true $\frac{1}{2}$ Laboured Hypothesis of Desaguliers & other must fall to the Ground. The Hypothesis is very plain, & exactly consistent w: all ^{the} the Phenomena.

The ascent of water into the Air when boiling is owing to Heat, in all other

of vapour

259

caus it is owing to solution.

The Conversion of Bodies into repellent vapour takes place both in vacuo & in the Open Air. After this begins to rise copiously no further Degree of Heat can be produced in the Liquor or other Matter. This Conversion of Bodies into vapour at a certain Degree of Heat occurs in all B^o.
- dies.

Besides, Fluids a boiling point is observed in many Solid Bodies reduced to a fluid Form. Of the metal: Claf. there are none but Gold & Silver w^h cannot be bro't to the point of evaporation in Chemi-
- cal

of vapour

Furnaces; & even then in $\frac{2}{3}$ Hours of
of a burning Glap have been conver-
-ted into vapour. if some Bodies are
capable of resisting this Heat, it may
be fairly attributed to the Defect of bio-
-ence in the Heat th w^e can apply, &
therefore ~~with~~ our Proposition will remain
- that in all Bodies a boiling point oc-
-curs th w^e all its Circumstances.,

The Phenomena th w^e occur generally at the
in boiling are 1st that when water receives
a Quantity of Heat it is expanded without
losing its Transparency. if After some time
we look Obliquely into the Glap we see

containing the water we shall perceive
an intestine motion & it is formed. After
this the Transparency is disturbed, but
recovered before boiling. —

When the Transparency is thus recovered
Bubbles arise from the Bottom, & other
Bubbles ^{as} were before at the Sides rise to
the top, and dissolve. towards ^{the} boiling
point the Bubbles rise most copiously, &
at that point numerous & large Bubbles
fly up to the Surface and explode. in this
- case the rushing of the Bubbles is
not so quickly performed. from ^{the} $\frac{2}{3}$ moment
too a part of the liquor is dissipated in ^{the} air.

of Vapour

Let us now endeavour to An^r: for these Phenomena. When Bubbles w^{ch} occur in boiling, must not be mistaken for Air or any Other Fluid w^{ch} can be contained in Vesels. D^r Boerhaave relates an Exp^t: from Mariotte by w^{ch} it appears that the Bubbles easily pierce thro' Glass and escape. Pollet relates something of the same kind wth regard to Mercury. Over a Bottle of which he tied a Bladder very accurately, made the Fluid boil - and found y^t y^e Sublimatⁿ: - escaped as easy, as if the Bladder had not been there. from this it appears y^t:

of vapour

It is not air, but a Subtile matter
passing from the burning Fuel into
the water that occasions $\frac{2}{3}$ Bubbles.

- all the other Phenomena may be
explained upon the same Principles.

- The Expansion necessarily enues
on the Entry of the Elastic Fluid. in most
Fluids uniting then occurs if properly view'd
a similar Appearance of Ice from the
motion of the one thro' the other. in Con-
sequence of further Diffusion, but not
proper mixture, more or less Capacity
occurs, ^{or} afterwards disappears when
the Mixture becomes more perfect. with

Of Vapour

much the same Appearance does the
Mixture of Alcohol & water take
place. first this appear^{ce} w: go off, &
are succeeded by a milky Appearance,
^{ch} w: when the mixture is finished become
again transparent. —

all these Phenomena tend to show us
y: in boiling a new matter is gradually
furnished equally dispersed thro the water.
at length a certain Quantity being intro-
duced the water can retain no more, but
the Elastic Fluid passing into it form those
Bubbles which appear at the bottom,
& w: in consequence of their Elasticity &

of vapour

215

less specific Gravity rise up to the Top. so
that all the Elastic γ : enters the water. &
at the point of Bullition flies off. This
does not depend on the nature of γ : water,
but is influenced by the pressure of the
Air on its Surface: and according as this
pressure is greater or less, the water will
retain a greater or less quantity of the
Elastic Fluid, & the Phenomena of
Bullition occur sooner or later. Thus by
an Experiment of Mr. Montaigne Sun it
appears γ : as we ascend higher into γ :
Atmosphere, water boils sooner, on the
Other hand in a Digestor in w: Air is in-
cluded

of vapour

I wth by heat will be enabled to exert
its Spring. the water may be heated
without boiling. to any Degree of heat
wth the strength of the vessel can bear.

As soon as water boils a Disipation
begins. this Disipation as carrying
away part of the mass of water, & conse-
-quently of the Fluid conjoined wth it might
be supposed to cool the Liqueur, but the Gas
-the Fluid enters in as great proportion
as it is carried off by Disipation. wth we
would chiefly infer from this is, a pretty
strong proof that the Action of Fire on

of vapour

Bodies depends on a Subtile Fluid enter-
 ing them, in certain Circumstances in
 a greater or lesser proportion. The Dis-
 tance of such a Fluid being granted, we
 can conceive how it may determine
 the Aggregation of Bodies. to explain
 its Effects a Postulum must be assumed,
 which indeed may be in some measure
 proved Viz: if the Atoms of Bodies ap-
 proach to a certain Degree of Contiguity,
 the Attraction between such contigu-
 ous Atoms will act less powerfully than
 that which is without them. This granted

of vapour

we can account for the Difference of
Aggregation in

When two Atoms approach as near $\frac{1}{4}$
the Action of the Ether without them, overcomes
that of the Ether betwixt them. These two
Atoms will be pressed together & form a
Solid. This will be more Cohesive in pro-
-portion to the closer Contiguity of the
Atoms.

The Attraction in the Expansion of a
Body will depend of the Quantity of Ether
in a Body. When this is in such a Con-
-dition that the Action of $\frac{1}{4}$ external &
internal Ether are in a Balance, $\frac{1}{4}$ Body

of vapour

becomes fluid. if we would to suppose
 that the internal overbalances the
 external Ether, then every particle is sur-
 -rounded wth an Elastic Atmosphere of ω .
 It is the Center, repelling every Ether parti-
 -cle & surrounded in the same manner & again
 repelled by these. a Body then will be in
 the State of vapour.

Besides the Effects of Ether already men-
 -tioned, it is probable y^t by $\frac{2}{4}$ Interposition
 of the Etherial Fluid, the boiling Liquor
 is never in actual Contact wth $\frac{1^{st}}{4}$ Bottom
 of the vessel. This will Ac^t for ω happens
 to heterogeneous Masses exposed to boiling.

of vapour

viz: that before boiling they are well
pounded, & let fall a matter to the
Bottom, w^{ch} sticking to the vessel is
more heated than the rest of the Liquor.

But if we can prevent ^{the} sticking of this
matter till the boiling begins, there is
afterwards no danger of such an accident.

Again. Formerly Observed y^t in Chemical
Operations we should never use such vessels
as are corroded by the matters to be put
in them. it is known however that Flanders
on the Acc^t of the Convenience of Copper
vessels, often boil Acids in them without

of vapour

bad Effects; but they always take care
to pour them in & out boiling, during
the time, by means of the Uddia Otton
they are prevented from touching the vessel.

— If in any case the boiling Liquor is of
considerable weight & viscosity, inasmuch
as to hinder the ascent of the Otton, and
force it back, on the bottom of the vessel,
it is easy to see that acting ag^t the
bottom & sides very powerfully, it will
break the vessel: hence the necessity of
thick bottoms to Crucibles. —

If one vessel of water be put into
another vessel of water, the water in the

Of Vapour

inner vessel will never boil, Altho' the Heat come up to the boiling point.

Water can receive only a certain Degree of Heat, for after this the Other flies off as fast as it enters. all this Other comes from the proper Surface of the external vessel, and therefore is superfluous & passes off thro' the water it contains, without entering the inner vessel. Hence there is no Appearance of Bullition of the latter.

Tho' we can explain thus the Phenomena of boiling, yet we are no more in a Condition to explain why it happens in different

of vapour

Bodies at different Degrees of Heat, than
we formerly were to explain under the
Head of Fluidity why Heat acted with
such various Effects on different Bodies.
— It is probable however that it does not
depend so much upon a Difference of
Mixture in Bodies as on their State of
Aggregation; for the Phenomena of
Boiling occur only in such Bodies as
are homogeneous, & suffer no Decom-
position during boiling. Thus Oils have
no boiling point since they are decomposed
by a boiling Heat; some parts flying off
& others remaining behind w^{ch} alter the

Of vapour

State of the Liquor, & its Aggregation.

In decomposed Liquors another Difference occurs; for when the vapours arising from them are condensed, they do not assume the usual Form of the Fluid, as happens in the vapours of homogeneous Fluids. Hence vapours may be either the constituent parts of a Misto, or ² y. Integrant parts of an Aggregate.

a Question properly occurs here. Why Solid Bodies are more subject to be decomposed by Evaporation than fluid Bodies? — To attempt a Solution of this we may say that Fluids do not resist the

of vapour

Action of Fire as much as Solids, and
 therefore are raised together. Whereas
 Solid Bodies often require such a Heat
 to fuse them as Aggregates, as is
 sufficient to decompose them as mixts.
 — Thus in the Calcination of Antimony
 while it continues in powder, it suffers
 a Decomposition, and $\frac{2}{3}$ sulphureous
 parts arise Only, Unless on the other hand
 the heat is raised to such a Degree as to
 cause a Decomposition of the metal.

Of Ignition

The Fourth, & next Effect of Heat w: we
shall mention is Ignition. This is
in some measure common to all Bo:
- this w: can sustain a sufficient Heat
without Dissipation. Ignition is attai-
- ned w: a certain Degree of Light of a
red Colour, tho' it differs from Inflam:
- mation. the former is an Affection of the
whole Mass; the latter is confined to the
Surface of the vapour of Bodies. Ignition
takes place wherever a sufficient Heat can
be applied to Bodies capable of it. Thus by
the help of a Lens we can ignite Bodies
in water or vacuo. on the contrary --

of Ignition

Inflammation cannot take place without a free Accession of common Air. — Whenever Inflammation happens a Decomposition takes place, but Ignition is not an Affection of particular Mixts. It is common perhaps to all Bodies ^{wh} are capable of bearing a certain Degree of Heat without Disipation. we cannot prove this from actual Experiment, but it plain from Sir Isaac Newton's Scale of Heat. That Ignition occurred at the same Degree of Heat in all the Bodies he tried. Sometimes it is attended with

of Ignition

Inflammation & Vaporation. these
however are the Effects of particular
Causes. —

5.th of Calcination. This Effect of
Heat tho usually confined to particu-
lar Bodies, is perhaps common to all.
Its Effects are to change either Solids or
Solids into a powdery friable matter. in
Mercury this was long ago observed. but
it is now established by Experiment ^{g.}
water & Alcohol may now be made to
undergo the same Change. Boyle's Exp.
have been confirmed by Geoffroy. &

of Calcination

Margraaf has shew'd the Effect in water.
It happens in all kinds of Bodies to w:^{ch}
a sufficient Degree of Heat is given,
and which will retain it. Gold & Silver are
the only Exceptions, and there is Reason
to suspect the same of those.

It appears that most Bodies when
calcined sufficiently acquire an Increase
of weight. This does not happen from the
Air since the same thing happens in vacuo,
nor by any gross matter from our culinary
Fires, since the Effect appears when the
Calcination is performed in the Fumes of

of Calination

a burning Glass. Tho' we have alledged,
& I hope with some reason, that the
Phænomena of Fire depend upon a Sub-
=tile Fluid, yet we must allow γ : it is
not entirely free of gross Matter, as in $\frac{2}{3}$:
Case of Air, and the Rubrical Fluid we
suppose therefore γ : the additional bright-
ness is caused by the Intrame of the gross mat-
=ter of the Fluid into the calined Sub-
=stance. Some suppose this to be owing
to the particular Matter of Fire & Mr Boyle
alleges it as a proof of the Ponderability

of Calvination

of Fire & Flame. considering ^{the} State
of the Other Phenomena we cannot
imagin it to be Fire itself, w^h gives the
weight. But rather the gross matter
adhering to it. -

6th of bitrification. In ^{an} ordinary
manner in w^h we see this take place, it
seems to belong to certain matter only.
Others however have maintained that
it is a universal Effect of Fire. we shall
not here enter ~~to~~ into this Dispute, but
only mention two Facts w^h are relative
to it 1st that in every Case of bitrification
- on it is preceded by Calvination, either as

of vitrification

in the Case of Metals when melted &c,
or in Other Cases by the Addition of
proper Matters. 2.^{ndly} It is constantly
attended w:th a Change of the Body from
an Opaque to a transparent Substance.
It is always necessary to the Transpa-
-rency of Bodies that they consist
into thin plates. We know y:^e most
- natural transparent Bodies are
- composed of such thin plates as Cry-
- stal Diamond &c, w:^{ch} may be either
seen or inferred from Experiment.
in Artificial Glass it is very difficult

of vitrification

to discover this Structure. it may how-
 ever be rendered evident by Duomps.
 position: for if we make Glass w: an over-
 proportion of Alkali, and apply an
 Acid to it, it may be separated into
 thin plates like the Leaves of a Book.
 so y: we have Reason to conclude y:
 Connection was in the same manner.

7th Inflammation. In treating of
 the other Effects of Fire we endeavoured
 to arrange them according to the Degree
 of Heat they required, beginning w: those
 which required least: so y: in this view

of Inflammation

Inflammation might have been spoken
of more early.

We have mentioned formerly that this
is an Affection of the vapours of Bodies.
of all the Effects of that likewise, it may
be most properly considered as depending
of the particular Nature of a Body. -
Notwithstanding the great Diversity of
Inflammable Bodies, we have given
Reasons for supposing that they may
all be comprehended under $\frac{2}{4}$ Articles
of Pil, Sulphur & Alcohol.

This Division I found to be pro:
per under the Chemical History of

of Inflammation

~~But~~ Inflammables. I would not
 however contend ² it is quite exact.
 For with a Diffusion of the matter be ne-
 cessary here, if we can find a common
 matter on which Inflammation depends.

— The three Substances above mentioned
 are extremely analogous to each other.
 I believe they are all compounds & that
 Phlogiston is also a compound Body.
 an Acid enters into the Composition of
 each of them without ^{ch} w: no Inflammable
 Substance has been yet found. It w: concei-
 -vable proportion it may enter into some

of Inflammation

of them appears from the Analysis
of Sulphur. From $\frac{1}{2}$ constant presence
of an Acid in inflammable bodies from
the Convertibility of an Acid into an
Inflammable & vice versa, we are led to
conclude that an Acid is absolutely ne-
cessary to Inflammability: but as Acids
by themselves are not inflammable, we
conclude also $\frac{2}{2}$: some other substance must
be united ^{to} an Acid to produce Phlogiston,
and that therefore it is a Compound. This
other Ingredient may probably be fixed
Air, for we know certainly $\frac{2}{2}$: it always

of Inflammation.

arises from burning Bodies. This notion
 was formerly printed but it might be
 illustrated from the Composition and
 Decomposition of Sulphur. at any rate
 by proving that Phlogiston is a compound,
 we have no room for supposing that
 Fire is an Elementary Substance, and
 take off the necessity of Attributing all the
 Effects of Fire to a peculiar Mist, this
 we may safely allow it in Inflammation.
 — Another Circumstance in Inflammation
 must be observed viz. the necessary Con-
 -currence of Air. a Question here occurs.

Of Inflammation

Whether Air be a *Pabulum Ignis*, or
Matter of Inflammation? It appears
that Air does not afford a *pabulum*,
since other Nastic Fluids in w^h we have
no grounds for supposing a *Pabulum*,
will equally well serve the purpose. nay
Air seems rather to absorb some Matter
evolved during Inflammation, which if
not thus taken away would extinguish
Flame. The Breathing of Animals is
some what Analagous to this; for the
same Air is necessary to Breathing as to
Inflammation. & that w^h is improper for
the one is improper likewise for the other.

Hence it is probable, that the Air serves
the same purposes in both Cases.

I refer you to Dr. Hales's Experiments on
these Subjects of Breathing & Inflammation,
for many Facts relating thereto. That
the matter exhaled from the Lungs is
fixed Air appears probable from its
Effects — in rendering Caustic Alkali
mild — extinguishing Flame &c. —
Finis.

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